Reconnaissance Report
Shore Protection And Erosion Control Project

Siasconset
Shore Protection Study
Nantucket, Massachusetts

US Army Corps
of Engineers
New England Division

June 1994

SECTION 103
SHORE PROTECTION AND EROSION CONTROL
RECONNAISSANCE REPORT

SIASCONSET SHORE PROTECTION STUDY
NANTUCKET, MASSACHUSETTS

1994
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NEW ENGLAND DIVISION

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The shore protection and erosion control study was conducted by the New England Division, U.S. Army Corps of Engineers at the request of the Town of Nantucket, Massachusetts. The study was funded under the continuing authority provided by the Corps of Engineers Section 103 of the 1962 Rivers and Harbor Act, as amended, for the purpose of shore protection and flood damage reduction from coastal storms. The Reconnaissance Report documented the study that concluded that the formulated plans to control erosion in the Siasconset Study Area are not economically justified and that there is no opportunity for further Corps of Engineers assistance for controlling erosion in the Siasconset Study Area.

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EXECUTIVE SUMMARY

This reconnaissance report was prepared by the New England Division, Corps of Engineers in response to a request from the town of Nantucket for assistance in solving the erosion problem along the Siasconset area on the southeastern coast of Nantucket. The study was conducted under the continuing authority of Section 103 of the 1962 Rivers and Harbor Act, as amended, for the purposes of shore protection and flood damage reduction from coastal storms. The purpose of the reconnaissance study is to analyze the problems of erosion along the Siasconset shoreline and to formulate and evaluate alternative corrective measures.

The Study Area consists of almost 3 miles of shoreline along the Siasconset coast on the southeastern shore of the island town of Nantucket in Massachusetts. See Figure 1. The Study Area is subject to high energy wind and wave action from the open Atlantic Ocean on its east. A continuous bluff, varying in height above the beach of 15 to 100' extends through the Study Area. This high bluff is lined with high value mainly seasonally occupied homes. At the southern end of the study area a berm or scarp averaging 12 feet Mean Tide Level (MTL) has been formed between the bluff and the shoreline. The berm is undeveloped except for an approximately 1250 foot length known as Codfish Park. Here smaller, closely packed, mainly seasonal, homes occupy the berm. The berm is the most vulnerable part of the study area to erosion.

The Siasconset shoreline has been undergoing severe erosion since 1957. During the 1992 storm six homes were lost in the Codfish Park area and since that time others have been lost or moved to other locations. Further north several homes have been moved back from the bluff. At Sankaty Light Station the residential buildings have been demolished and removed from the path of the receding bluff.

In the absence of Federal action erosion will continue at the historical rate and an estimated $66 million in property losses ($53 million in land and $13 million in structures) will occur over the next 50 years.

This study assesses the feasibility of protecting three discrete areas of developed and developable land, since they would have a greater chance of obtaining economic feasibility. Protection of virtually the entire study area is also considered.

A number of alternatives for controlling erosion in the Siasconset Study Area were formulated and evaluated. An offshore breakwater was found not to be economically feasible. Certain design considerations such as protection from flanking and overtopping, render a revetment uneconomic.

Alternative sandfill protection plans accompanied by periodic sand nourishment to restore, as necessary, project dimensions were considered in some detail. The sandfill was designed with a 100-foot berm and a seaward slope of 1 vertical and 15 horizontal. Two options were considered. One offered protection from a 100-year recurrence storm event and the second from a 50-year recurrence event.

Sandfill costs were based on the use of offshore sand borrow sources located by consultants in earlier studies. The analysis led to the finding that none of the sandfill alternatives are economically feasible.

Further Federal participation in Section 103 Authority studies to protect the Siasconset shoreline is not warranted and Corps of Engineers involvement ends with the publication of this report.

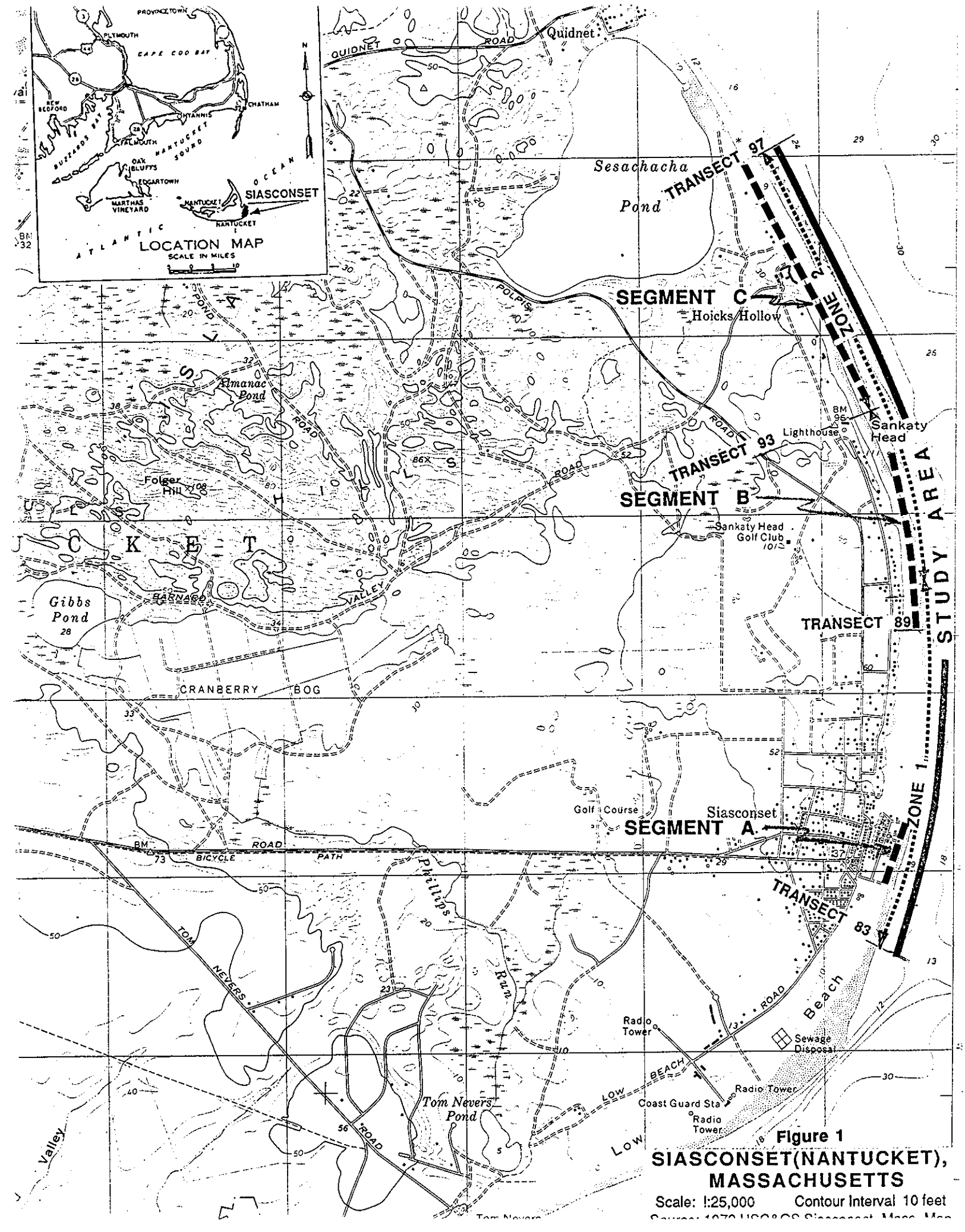

Figure 1

SIASCONSET(NANTUCKET), MASSACHUSETTS

Scale: 1:25,000 Contour Interval 10 feet

SIASCONSET, NANTUCKET, MA

Bluff-vicinity Sankaty Light Station -
Looking Northwest
August 1988

SIASCONSET, NANTUCKET, MA

Codfish Park and North - Looking West
(Note: Developed and undeveloped berm
and developed backshore bluff)
August 1988

SIASCONSET, NANTUCKET, MA

Codfish Park - House Abandoned to Erosion
February 1994

SIASCONSET, NANTUCKET, MA

North of Codfish Park - Looking North
(Note: Undeveloped berm and developed backshore bluff)
February 1994

ABBREVIATIONS

CDS	Coastal Drain System
CPAR	Construction Productivity Advancement Research
cy	cubic yard,s
Ft	feet
H	horizontal
MTL	Mean Tide Level
NED	National Economic Development
Ru	wave runup
SBPF	Siasconset Beach Preservation Fund, Inc.
Sw	wave setup
V	vertical

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I MAIN REPORT

Chapter 1
INTRODUCTION

STUDY AREA

The Siasconset Shore Protection Study is limited to an approximately 15,750 foot segment of the southeastern shore and corresponding backshore of Nantucket, Massachusetts extending from approximately 1250 feet south of Codfish Park to Sesachacha Pond or from transects 83 to 97 in Figure 1. Nantucket, Massachusetts is located some 30 miles south of Chatham on Cape Cod and 20 miles east of Martha's Vineyard. The 9 by 13 mile island is bounded by Muskeget Channel to the west, Nantucket Sound on the north and the Atlantic Ocean on the east.

STUDY AUTHORITY

This report was prepared under the Continuing Authority of Section 103 of the 1962 Rivers and Harbor Act, as amended, for the purposes of shore protection and flood damage reduction from coastal storms. The Section 103 Authority authorizes the Chief of Engineers of the U.S. Army Corps of Engineers to conduct pre-authorization studies for shore protection studies and, if appropriate, construct them.

STUDY OBJECTIVE AND SCOPE

The purpose of this reconnaissance study is to determine whether further planning to alleviate storm damages in the Siasconset Shore study area is justified from the point of view of the Federal Government.

PRIOR STUDIES AND REPORTS

A number of studies have been undertaken to address the erosion of the Nantucket shoreline or more specifically erosion along the Siasconset shore and mitigating measures. The reports for these studies are:

- Gutman, Andrew L.; Goetz, Michael J.; Brown, Francisca D.; Lentowski, James F.; Tiffney, Jr., Wesley N., Nantucket Shoreline Survey, MIT Sea Grant College Report MITSG 79-7, August 1979. The report documents changes in the Nantucket shoreline over a period of 125 years from 1846 to 1971.

- U.S. Army Corps of Engineers, New England Division, Nantucket Island, Massachusetts - Report on Shoreline Erosion at Sankaty

Light, 12 December 1985. The report documented a study on shoreline erosion extending from Sankaty Light to one-half mile south along Nantucket's eastern shoreline.

- U.S. Army Corps of Engineers, New England Division, Lighthouse Protection Studies, New England - Sankaty Light Station, Nantucket, Massachusetts, 1989. The report recommended relocating or reconstructing the light station at a new location when erosion of the edge of the bluff is 50 feet from the light station.

- Aubrey Consulting Company, Falmouth, Massachusetts, Siasconset Beach Nourishment Project - A Feasibility Study, April 1992. The conclusion of the preliminary assessment is that there are no fundamental engineering problems that would prevent the completion of a beach nourishment project over approximately 14,000 feet of Siasconset shoreline.

- Aubrey Consulting Company, Falmouth, Massachusetts, Siasconset Beach Nourishment Project - Phases 1 to 4, October 1992. The report addressed the location and suitability of offshore sources of sand.

- Coastal Engineering and Planning, Inc., Boca Raton, Florida, Conceptual Design Report for Beach Erosion Control at Siasconset, Massachusetts, June 1993. The report concluded that there are three options for protecting approximately 14,000 feet of Siasconset shoreline. The preferred option was sandfill along 14,000 feet of shoreline with a berm at an elevation of 10 feet Half Tide Level (HTL) and approximately 180 feet wide including advanced nourishment and periodic nourishment.

- Fessenden, Franklin W., Report on Siasconset Study Area, 16 November 1993.

- Fessenden, Franklin W., Siasconset Bluffs - Erosion Data Through 2-3 October 1993.

- Fessenden, Franklin W., Report of 15-16 January 1994 Site Visit.

In addition, the following report provides state of the art documentation on a technology known as the Coastal Drain System for reducing erosion and/or promoting accretion on beach faces.

- Danish Geotechnical Institute, Lyngby, Denmark, Case History Documentation for Beach Management System and Stabeach, 11 December 1992.

Chapter 2
EXISTING CONDITIONS

PHYSICAL SETTING

The Study Area consists of approximately 15,750 feet of shoreline, exposed to the Atlantic Ocean from the east, and a corresponding backshore in Siasconset on southeast Nantucket extending from transect 83 to 97 as shown on Figure 1. The study area is bounded by a continuous bluff varying in height above the beach of 30 feet in the south to about 100 feet in the area of Sankaty Light Station and then diminishing to 15 feet at transect 97. The study area is divided into two zones. Zone I is characterized by a backshore berm or scarp, averaging about 12.5 feet Mean Tide Level (MTL) in elevation, that is located between the beach and the bluff from transect 83 to 90. The berm is approximately 340 feet at transect 83 and gradually reduces to zero near transect 90. In Zone II the toe of the bluff is directly vulnerable to wind and wave action.

Zone I contains a vegetated backshore berm between the beach and the bluff, which is the product of an accretionary process from the period between 1846 and the 1950's and 1960's. The berm varies from about 9 to 16 feet (MTL) in elevation and averages approximately 12.5 feet (MTL). It was 340 feet wide at transect 83 in 1992 and gradually narrowed to zero at transect 90. The edge of the coastal bluff rises from an elevation of about 40 feet (MTL) at transect 83 to nearly 75 feet at transect 90. The shoreline in this area accreted since 1846, when monitoring of the shoreline began, to 1955, thereby advancing the shoreline some 300-450 feet seaward during this period. The rate of accretion was greatest towards the south and lessened gradually towards the north. However in the 1950's and 1960's this pattern reversed to start an erosional trend that continues to today. From 1957 to 1992 erosion in Zone I has averaged between 5.3 and 7.7 feet per year or a total between 132 and 192 feet for the period.

The low beach, as the backshore berm is known locally, is relatively undeveloped except for an approximately 1250 foot stretch known as the Codfish Park section of the village of Siasconset. This area contains a developed residential community of closely packed single family structures, narrow streets, and water distribution and sewerage collection systems. Electrical services are supplied from overhead lines. No piped gas service exists. Although smaller and of generally modest construction than homes located on the top of the bluff, those in Codfish Park are nonetheless of high value. The berm to the north of Codfish Park is devoid of structures. It is vegetated mainly with beach grass and scattered pines. The slope of the bluff is, however, densely vegetated. Larger lower density residences appear along the rim of the bluff as one moves north from Codfish Park. Baxter Road and

further west, Sankaty Avenue, provide access into the area. Residences east of Baxter Avenue have commanding views of the open Atlantic Ocean. Unlike the properties in Codfish Park that are under immediate threat from erosion, those located along the bluff in this area are somewhat protected from imminent erosion by the backshore berm.

Zone II north of transect 90 a coastal bluff is located immediately to the backshore. Vegetative cover exists on the slope of the bluff only where it is relatively stable. The top edge of the bluff varies in elevation approximately 75 feet (MTL) to a maximum of 112 feet (MTL) south of Sankaty Light Station to 25 feet at transect 97. The accretion process (1846 to the 1950's and 1960's) described above gradually reduced to zero in the vicinity of the Light Station and has generally been erosional since. Between 1846 and 1970 erosion varied from less than 1 foot to less than 3 feet per year except that between 1951 and 1961 the shoreline was relatively unchanged. Between 1957 and 1992 this portion receded at an annual rate of 6.6 and 5.3 feet per year respectively at transects 90 and 91 and between 2.9 and 4.3 feet further north to transect 97.

The area above the bluff is continuous from Zone I. Further north is Sankaty Light Station and an area of more sparsely developed homes and a beach club. Many of the homes are threatened as the eroding bluff approaches them. Several structures have been relocated back from the bluff. Sankaty Light Station was less than 100 feet from the bluff in 1992. The residential buildings have already been removed, only the lighthouse tower remains.

HISTORICAL/CULTURAL SETTING

The American whaling industry originated on Nantucket in the late 17th century and remained vibrant until the 1840's when the nearby mainland city of New Bedford captured the trade. The settlers followed the example of the original Native American inhabitants. Evidence of the whaling industry is preserved in the early whaling stations located along the coast, including Siasconset during the 1660-1670 period, together with accompanying settlements. Sankaty Light Station, located towards the north end of the study area dates from 1849. Today Nantucket retains the ambiance of earlier times. The entire island of Nantucket, and the Sankaty Light Station itself, are National Historic Landmarks and listed in the National Register of Historic Places. Three structures constructed on Broadway within the village of Siasconset (Codfish Park area): Auld Lang Syne Cottage, which dates from 1676 and Rose Cottage and Shanunga from about 1682 are listed on the National Register nomination for Nantucket Island.

Chapter 3
PROBLEM IDENTIFICATION AND OPPORTUNITIES

STATEMENT OF PROBLEM

The Siasconset study area shoreline has been undergoing significant and accelerated erosion since 1957. Table 1 summarizes the historical erosion in the study area. As mentioned earlier the erosion reversed an earlier pattern of accretion south of transect 90 and prior to 1957 when the backshore berm or shelf was formed. Generally the rate of erosion has been higher in Zone I or transects 83 to 90 where the backshore berm or shelf is located. Here the erosional forces are less challenged due to the more recent consolidation of the materials and because the shelf is considerably lower than the exposed bluff found further north. For the period 1957 to 1992 erosion has varied from an average of 2.9 feet per year and totalling 100 feet to 7.7 feet per year totalling 268 feet at transect 87. The Codfish Park shoreline has eroded more than 200 feet while the bluff opposite Sankaty Head Light Station receded about 150 feet.

Not only has the erosion been significant, but it has also accelerated. While the maximum erosion during the 1957-77 and 1977-90 periods respectively were 8.8 and 10.6 feet per year, the erosion during the two year period from 1990-92 varied from 9 feet per year at Sankaty to 42 feet per year at Codfish Park.

During the December 1992 storm six houses were lost in the Codfish Park area. Since that time several others have been lost or moved to other locations. Further north several homes have been moved away from the cliff edge. The residential buildings for Sankaty Light Station have been demolished and removed from the path of the receding bluff. The beach club north of transect 95 has also moved buildings back from the bluff.

NO ACTION CONDITION

The no action condition is the most likely condition that is expected to occur in the Study Area in the absence of any public or private action to arrest erosion and alleviate the consequent damages to public and private property. The no action condition is a more severe future condition than the without project condition. In the no action condition, it is assumed that none of the actions expected to be undertaken by individuals or the Siasconset Beach Preservation Fund, Inc. to alleviate the damages from individual storms and long term erosion would be undertaken.

WITHOUT PROJECT CONDITION

The without project condition is the most likely condition that is expected to exist in the study area during the 50 year

Table 1
Siasconset Shore Protection Study
HISTORICAL EROSION

Transect Number	E R O S I O N (FT) 1957-77	1977-90	1990-92	Total Erosion 1957-92	Average Annual Erosion (Ft/Year) 1957-92
83	75	100	56	231	6.6
85	138	13	85	235	6.7
86	88	75	39	201	5.8
87	100	138	30	268	7.7
88	175	38	32	245	7.0
89	100	50	35	185	5.3
90	175	63	45	233	6.6
91	96	62	33	191	5.5
92	62	25	21	108	3.1
93	44	88	18	150	4.3
94	19	63	21	103	3.0
95	19	64	24	107	3.1
96	50	31	26	107	3.1
97	62	13	26	100	2.9

Source: Fessenden, Franklin, Ph.D., Professor of Geology, Bentley College, Waltham, Massachusetts, 02154, Letter dated 2 February 1994.

period of evaluation in the absence of a federal project to improve conditions for those properties subject to accelerated erosion along the Siasconset shoreline.

In the absence of federal involvement, it is expected that the Siasconset Beach Preservation Fund, Inc. (SBPF), in cooperation with the town of Nantucket, will continue to act on behalf of residents of the area. The SBPF is the successor to the Siasconset Erosion Committee, which brought residents of the study area together for the purpose of volunteering their time and resources to monitor conditions along the shoreline and to find feasible, affordable and environmentally compatible solutions to the serious problem of erosion. The group has succeeded in mobilizing the funding and has engaged several consulting firms to study shoreline conditions and to propose solutions. In a letter to the New England Division, Corps of Engineers, Division Engineer dated 17 December 1993, the Chairman of the Board of Selectmen for the town of Nantucket noted that the SBPF has concluded that the technology for the Coastal Drain System (CDS) or beach dewatering offered the best solution to mitigating against the eroding shoreline. See Appendix E for further details on the CDS. The SBPF is seeking funding to demonstrate the feasibility of the implementing the CDS along 5850 feet of shoreline in four locations: Codfish Park, 1250 feet; Backshore Berm, 500 feet; Baxter Road/Sankaty, 3100 feet; and Hoicks Hollow, 1000 feet. The SBPF is coordinating a proposal with the firm, Coastal Stabilization, Inc., to the Corps' Construction Productivity Advancement Research (CPAR) Program.

However, in the absence of a successful CDS application and federal efforts along the shoreline, it is most likely that erosion will continue unabated thereby causing the continued loss of land, homes, utilities, etc. along the Siasconset shoreline. As erosion approaches, those residents, whose properties permit, may move their structures further back from the rim of the bluff. Others may relocate their homes to other properties. Table 2 presents the projected erosion over a fifty year period in tabular form and graphically in Figures 2 to 8. It is estimated that approximately $66 million ($53m in land and $13m in structures) would be lost over a fifty year period if erosion were to continue in the Study Area.

A preliminary assessment indicates that those parts of the Study Area with substantial developed and developable land are the more likely to warrant federal participation in erosion control measures because of the value of the properties to be protected. The Study Area has therefore been divided into three segments: Codfish Park, 1,250 feet; Baxter/Sankaty, 4,480 feet; and Hoicks/ Sesachacha, 5,450 feet. Excluded portions of the shoreline are the length from Transect 83 to Gulley Road and the north end of Codfish Park to Transect 89 with a large area of land subject to erosion that is not developable.

Table 2
Siasconset shore protection Study
PROJECTED EROSION

Transect Number	Projected Erosion (feet) 1992-2042
83	330
85	336
86	288
87	383
88	350
89	264
90	332
91	273
92	154
93	214
94	148
95	153
96	153
97	143

Source: Fessenden, Franklin, Ph.D., Professor of Geology, Bentley College, Waltham, Massachusetts 02154, Letter dated 2 February 1994.

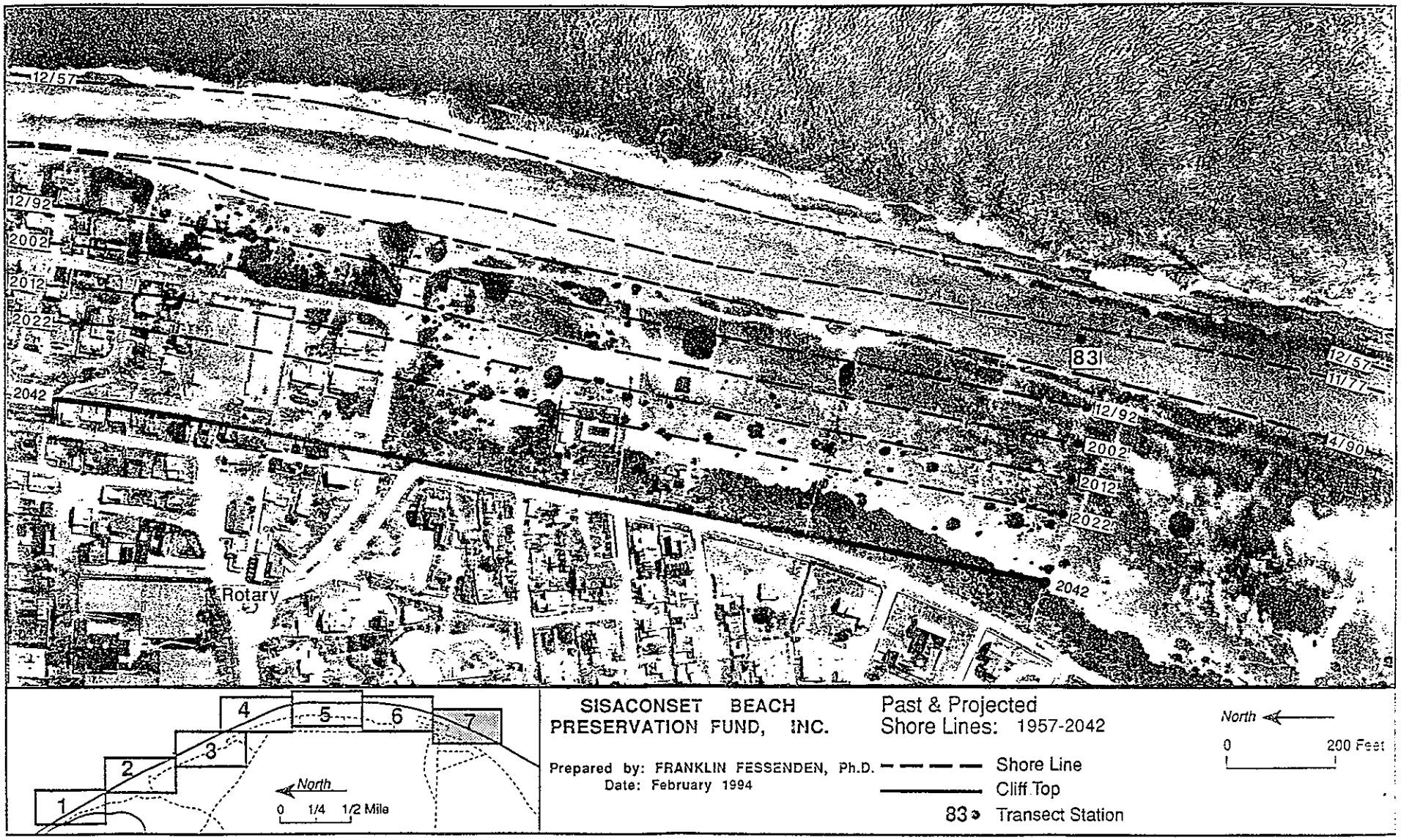

12/57
12/92
2002
2012
2022
2042
Rotary
83
11/77
4/90
1
2
3
4
5
6
7
North
0 1/4 1/2 Mile
SISACONSET BEACH
PRESERVATION FUND, INC.
Past & Projected
Shore Lines: 1957-2042
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Date: February 1994
Shore Line
Cliff Top
Transect Station
North
0 200 Feet

Figure 2

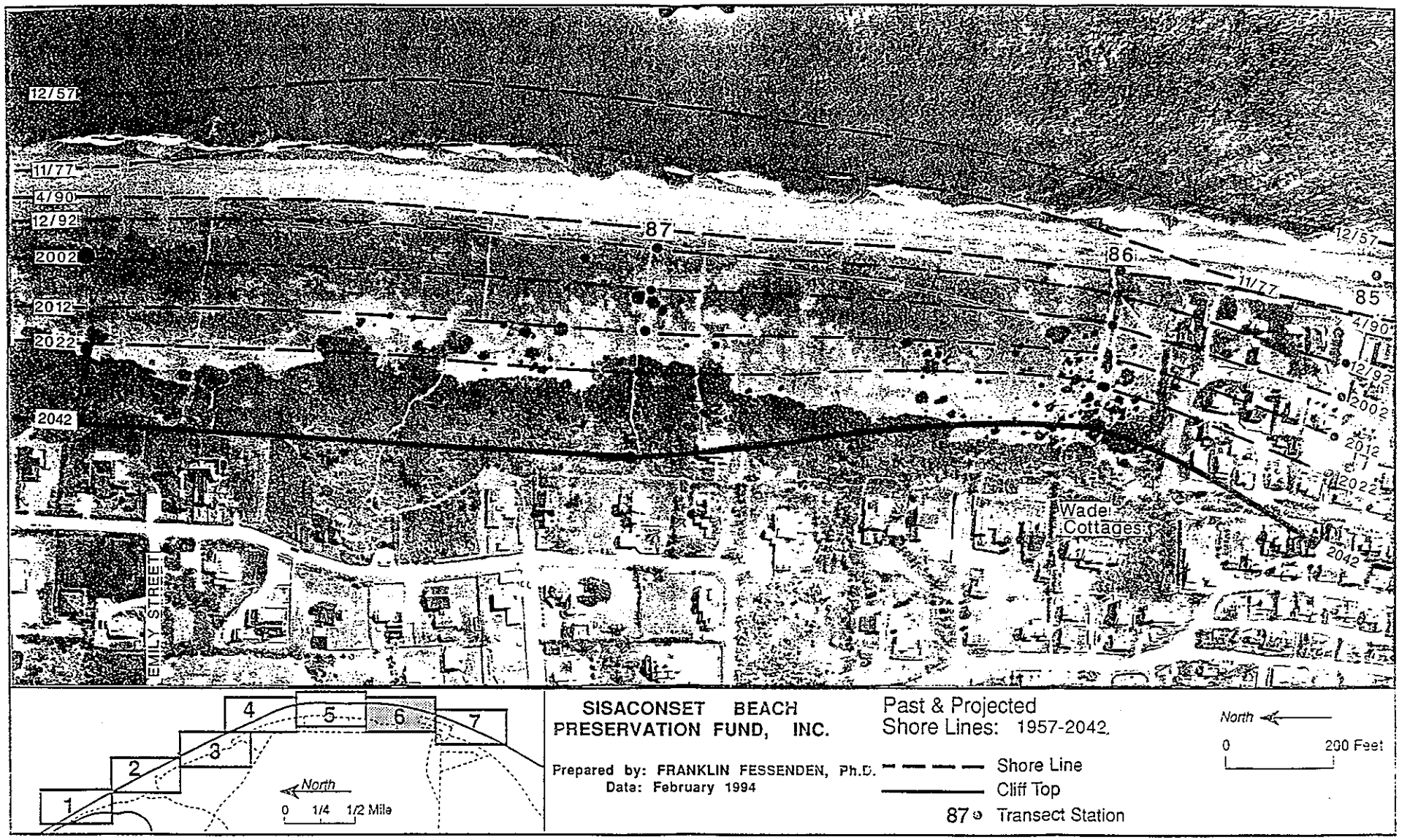

12/57
11/77
4/90
12/92
2002
2012
2022
2042
87
86
85
EMILY STREET
Wade Cottages
1
2
3
4
5
6
7
North
0 1/4 1/2 Mile
SISACONSET BEACH PRESERVATION FUND, INC.
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Data: February 1994
Past & Projected Shore Lines: 1957-2042
Shore Line
Cliff Top
87 Transect Station
North
0 200 Feet

Figure 3

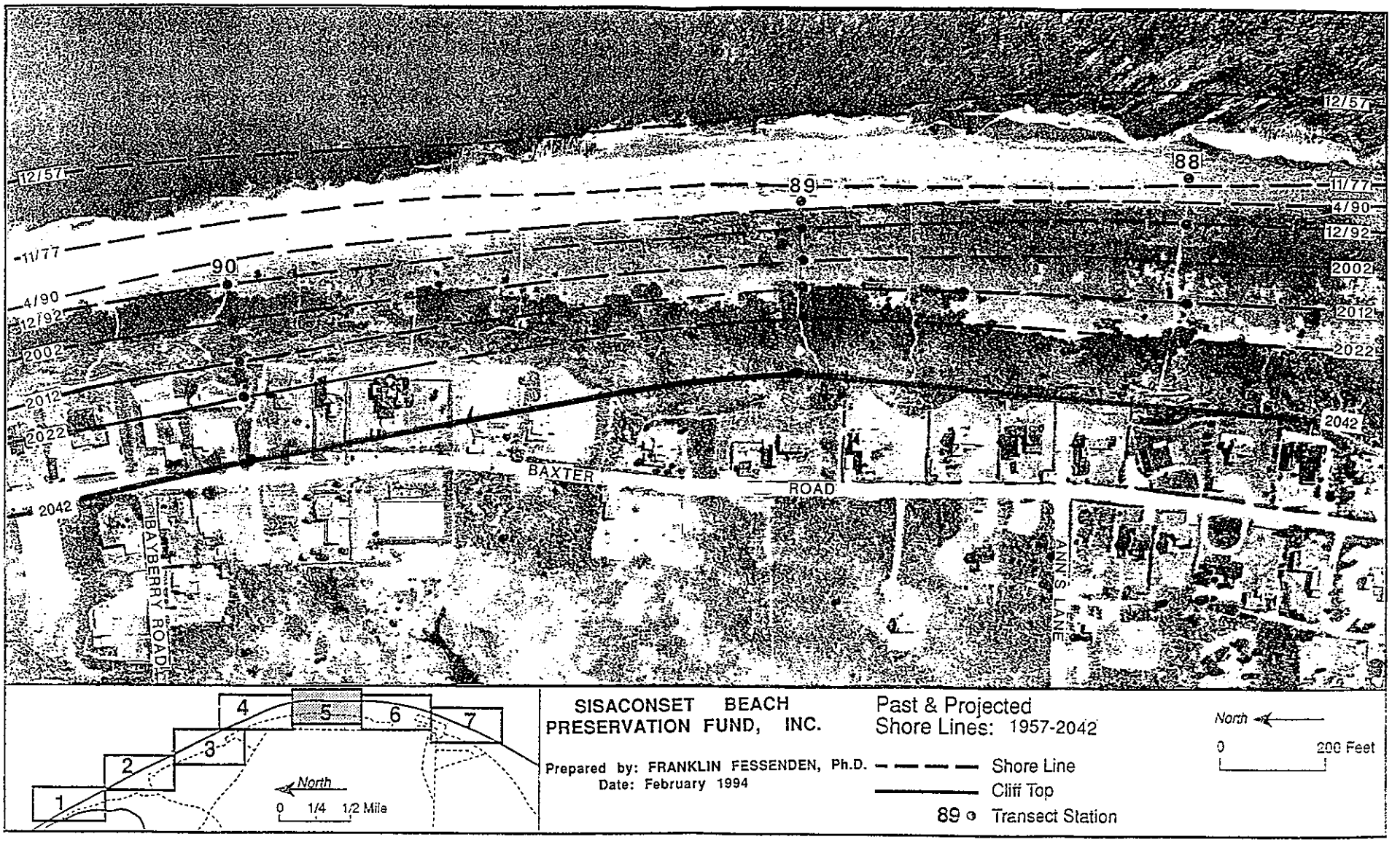

12/57
11/77
4/90
12/92
2002
2012
2022
2042
88
89
90
BAXTER ROAD
BAYBERRY ROAD
ANN'S LANE
1
2
3
4
5
6
7
North
0 1/4 1/2 Mile
SISACONSET BEACH PRESERVATION FUND, INC.
Past & Projected Shore Lines: 1957-2042
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Date: February 1994
Shore Line
Cliff Top
89 Transect Station
North
0 200 Feet

Figure 4

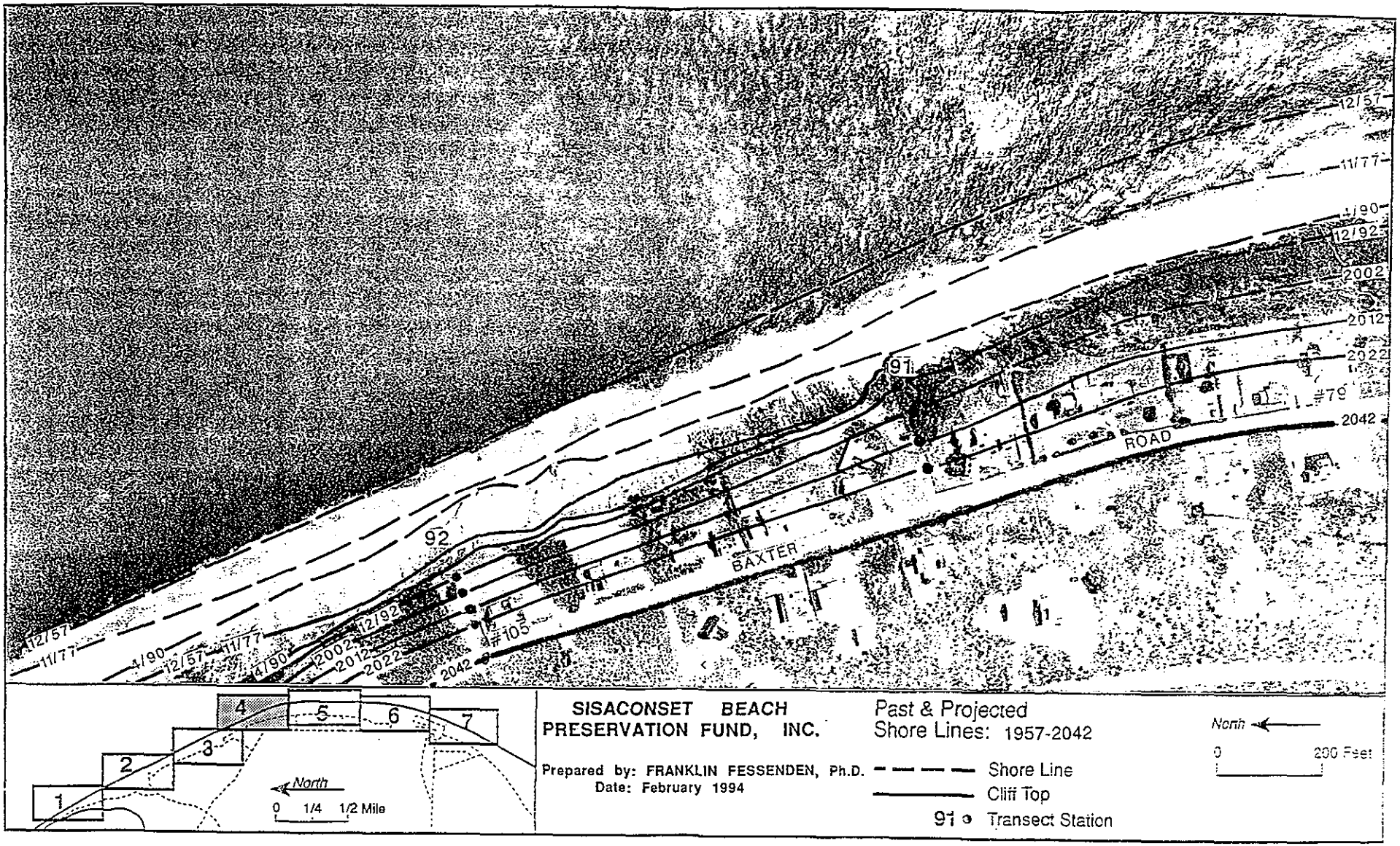

12/57
11/77
4/90
12/92
2002
2012
2022
2042
91
92
#79
#105
BAXTER
ROAD
1
2
3
4
5
6
7
North
0 1/4 1/2 Mile
SISACONSET BEACH
PRESERVATION FUND, INC.
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Date: February 1994
Past & Projected
Shore Lines: 1957-2042
Shore Line
Cliff Top
Transect Station
North
0 200 Feet

Figure 5

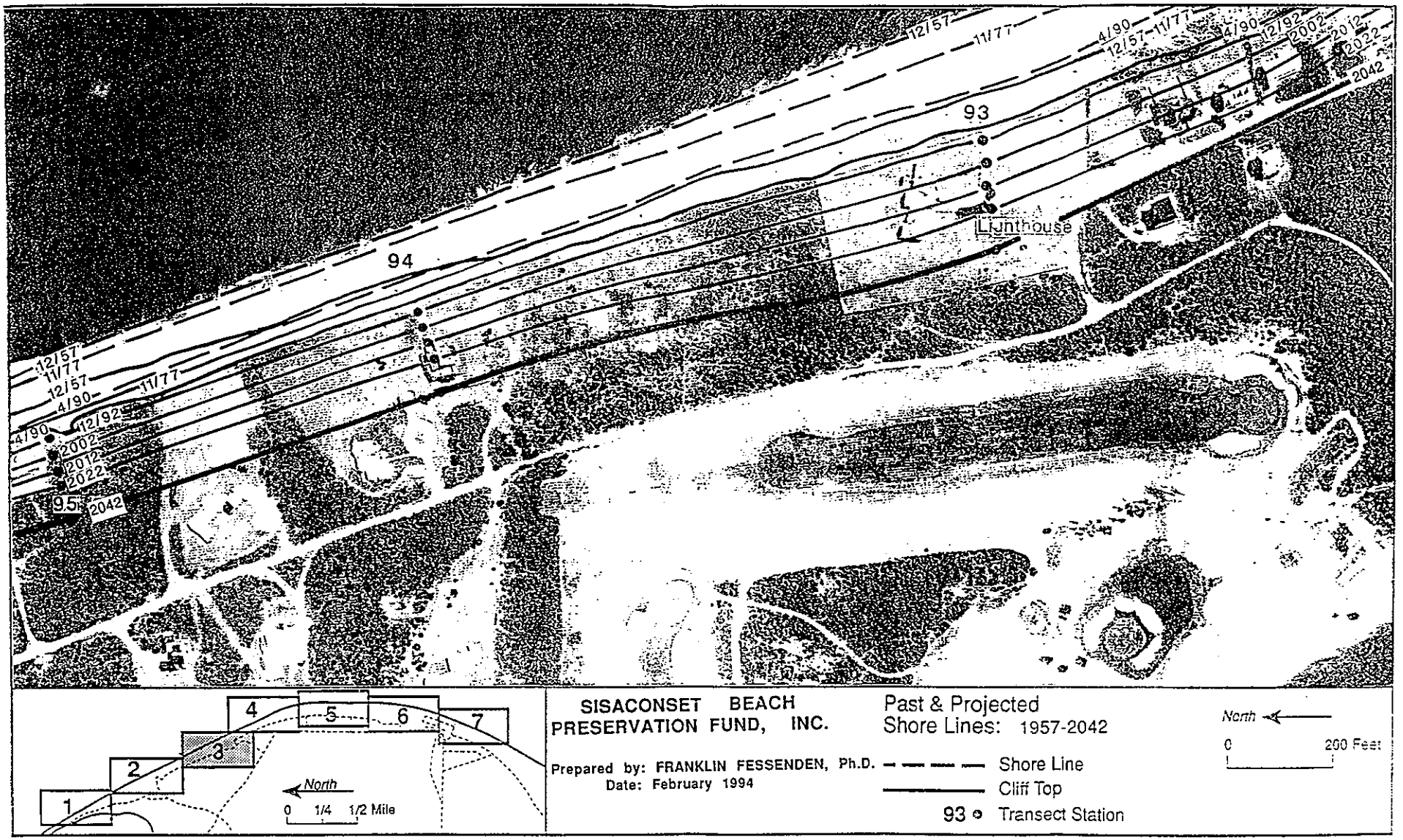
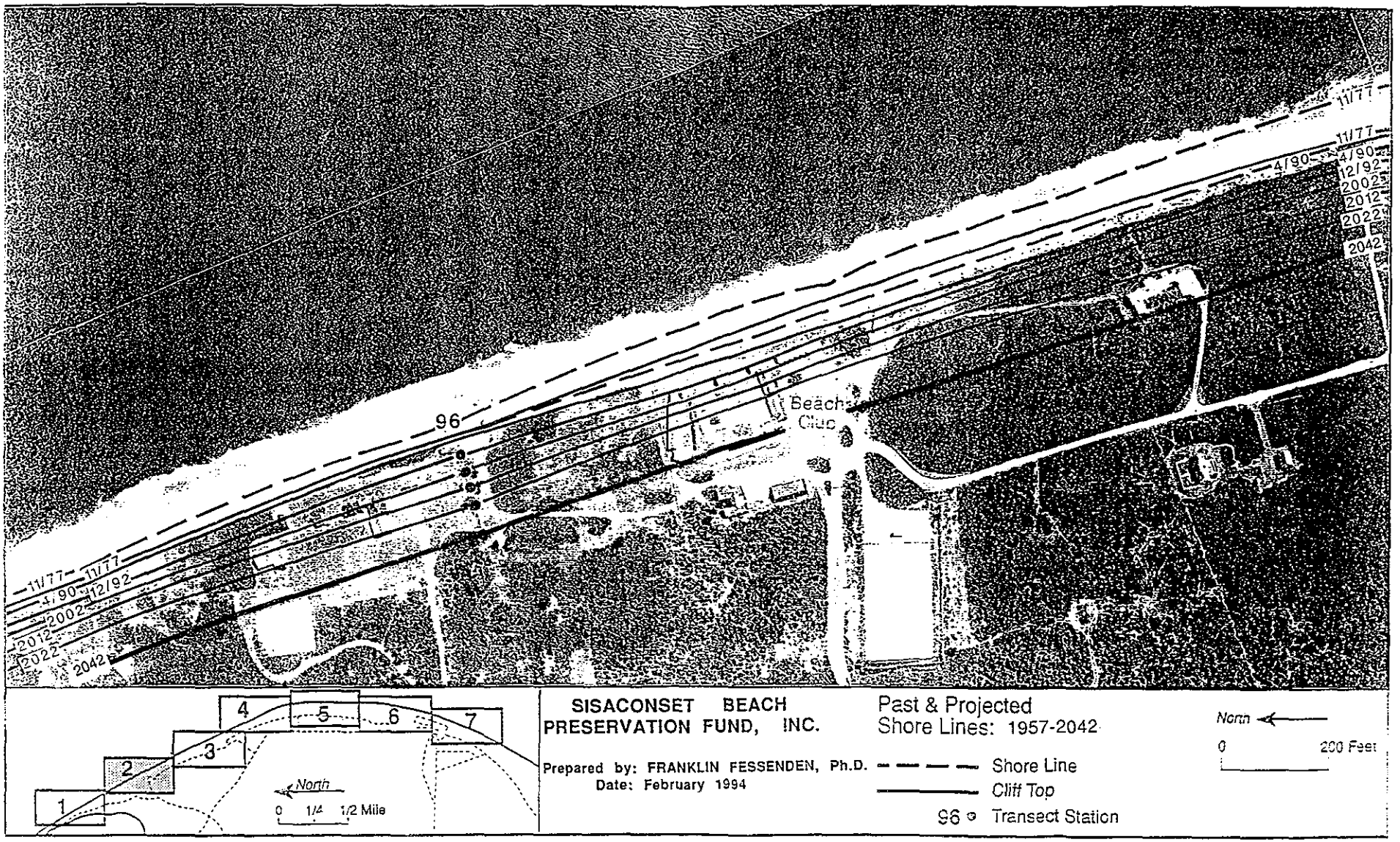

12/57
11/77
4/90
12/57-11/77
4/90
12/92
2002
2012
2022
2042
93
94
95
Lighthouse
4
5
6
7
3
2
1
North
0 1/4 1/2 Mile
SISACONSET BEACH
PRESERVATION FUND, INC.
Past & Projected
Shore Lines: 1957-2042
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Date: February 1994
Shore Line
Cliff Top
93 Transect Station
North
0 200 Feet

Figure 6


11/77
11/77
4/90
12/92
2002
2012
2022
2042
96
Beach
Club
11/77
11/77
4/90
12/92
2002
2012
2022
2042
4
5
6
7
3
2
1
North
0 1/4 1/2 Mile
SISACONSET BEACH
PRESERVATION FUND, INC.
Past & Projected
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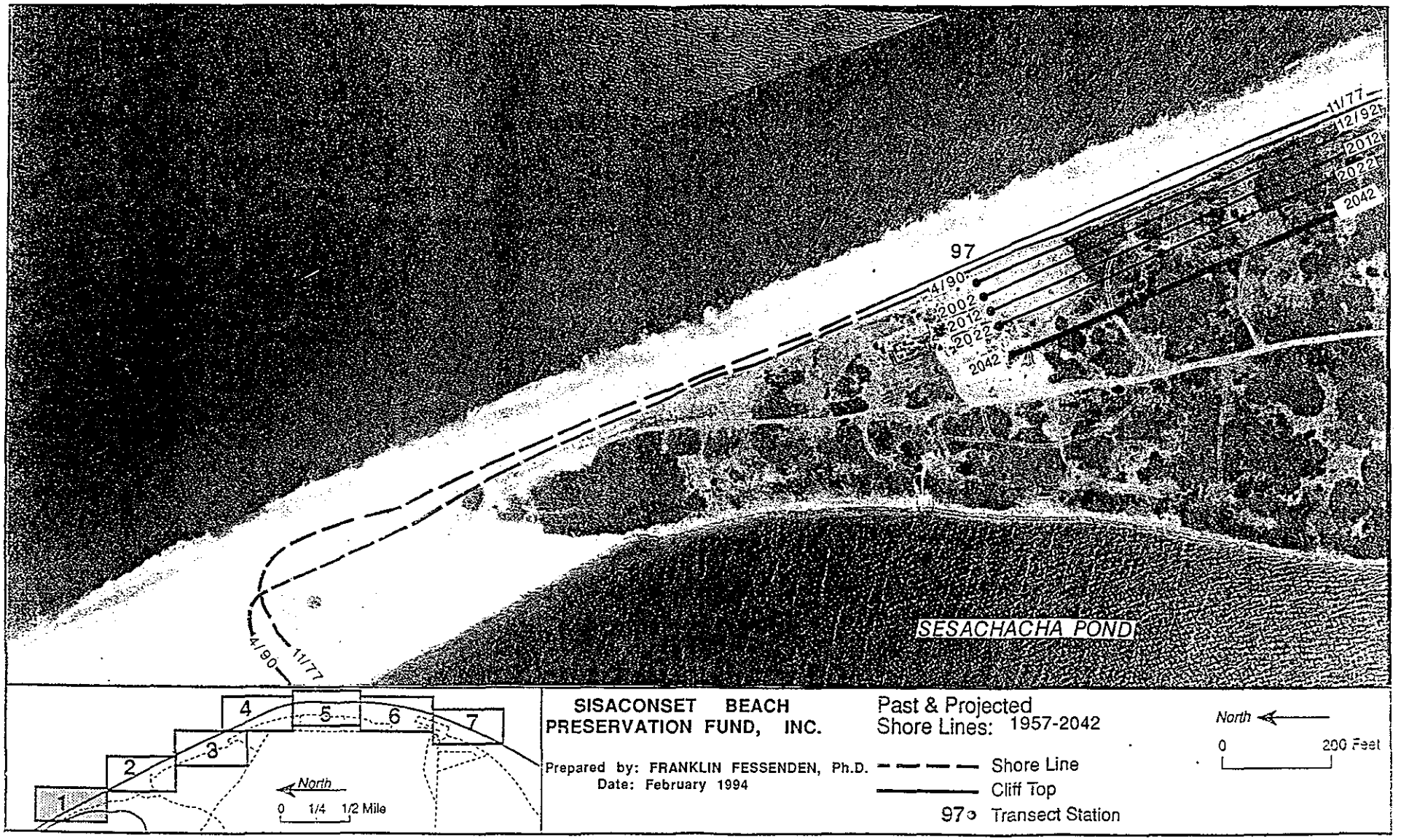
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Date: February 1994
Shore Line
Cliff Top
96 Transect Station
North
0 200 Feet

Figure 7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11/77
4
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2
1
North
0 1/4 1/2 Mile
SISACONSET BEACH PRESERVATION FUND, INC.
Past & Projected Shore Lines: 1957-2042
Prepared by: FRANKLIN FESSENDEN, Ph.D.
Date: February 1994
Shore Line
Cliff Top
97 Transect Station
North
0 200 Feet

Figure 8

Segment A - Codfish Park

Segment A or Codfish Park extends north from Gulley Road some 1,250 feet to about 350 feet north of transect 85. Here continued erosion of this backshore berm or low beach, as it is known locally, over a 50-year period would move it some 300 feet landward erode over 12 acres of developed and developable land and destroy homes, utilities and roads. Land and structural losses are estimated at $11.6 and $2.6 million respectively. No major water, sewer or storm drains would be affected. Traffic disruption would affect local transport only.

Segment B - Baxter/Sankaty

Segment B extends some 4,480 feet north from Transect 89 to 93. Continued erosion over the 50-year period would move the bluff between about 260 to 330 feet landward thereby resulting in the loss of nearly 24 acres of land valued at about $ 22 million and residential structures worth an estimated $9 million, as well as Sankaty Light Station which would cost an estimated $2.2 to rebuild. By the end of the 50-year period, the edge of the bluff is projected to extend to Baxter Road thereby disrupting transport, and water and sewer services for the properties north of Bayberry Road and west of Baxter Road.

Segment C - Hoicks/Sesachacha

Segment C extends some 5,450 feet north from transect 93 to 97. Continued erosion for the 50-year period cause the bluff to recede between 143 and 214 feet. Structures, including a beach club, valued at an estimated $1.4 million and 21 acres of land worth approximately $19 million would be lost to erosion.

PROBLEM AND OPPORTUNITY STATEMENTS

Problem and opportunity statements were derived from current areas of public concern and from future concerns that would be a consequence of the most likely conditions that are likely to occur in the project area in the absence of corrective federal measures or in the without project condition. The statements define the water and related land resource management needs that can enhance the National Economic Development (NED) account. Based on the predicted problems in the without project condition, the following opportunity statements were established:

- Reduce erosion to the backshore berm and bluff and contribute to the stabilization and protection of the backshore,

- Alleviate storm damages by reducing wave action and flooding

of backshore properties, structures, utilities (water, storm and sanitary drainage) and roads,

- Enhance the economic strength and well-being of the area,

- Contribute to the enhancement of the environment and the recreational opportunities in the area.

In short, a need exists to provide protection from erosion to the backshore berm and bluff and corresponding public and private properties in the Siasconset Study Area. The enhancement of the economic strength, well-being, environment and recreational opportunities of the study area would be by-products of erosion control measures.

Chapter 4
PLAN FORMULATION

PRELIMINARY SCREENING

A number of alternatives have been considered for improving conditions in the Study Area as a result of persistent shoreline erosion. Alternative hurricane and storm damage reduction measures may reduce the vulnerability of private and public properties to damages or they may reduce the damages themselves.

By definition none of the vulnerability reduction measures such as relocation, and the purchase of insurance would satisfy the opportunity statements presented above for reducing erosion and alleviating storm damages. Since flooding is not a major problem, floodproofing, floodwarning and evacuation, etc are not feasible options.

Three alternatives have been considered for reducing hurricane and storm induced erosion of the Siasconset shoreline and the consequent damages to private and public property: a breakwater, revetments, and sandfill protection.

Offshore Breakwater

An offshore breakwater is designed to provide protection to an area or shoreline located on the leeward side of the structure. A breakwater reduces the amount of wave energy reaching the water and shore on its lee thereby impeding the erosion of the shoreline. The reduction of wave energy can also have the disadvantage of reducing the movement of sand along the shore, and its accretion between the breakwater and the shore and conceivably causing a tombola and less sand nourishment to downdrift beaches. Breakwaters are generally offshore stone rubble-mound structures designed to withstand severe wave action. The estimated cost of an offshore breakwater, installed in relatively deep water and exposed to open ocean deep water waves, has been found to be far in excess of the benefits to be derived from protecting either part of or the entire Siasconset shoreline. Breakwaters have, therefore, been excluded from further consideration in this study.

Revetment

A revetment is placed parallel or nearly parallel to the shoreline to separate the water area from the land area. Rigid cast-in-place concrete or flexible surfaces using quarrystone or riprap or concrete blocks are placed on sloping banks to protect them. Revetments dissipate wave energy by deflecting waves up their sloped surfaces. Flexible surfaces, and particularly the armor stone, are favored because of their ability to tolerate minor consolidation or settlement. The functional integrity of the

revetment is dependent on the structural stability of the armor stone as well as the soils beneath them and the depth of the footings for support.

Revetments protect only land immediately behind them. They offer no protection to areas up or down coast nor to the beach seaward of the revetment. If a revetment were constructed along the beach berm at Codfish Park or further north along the bluff, waves would frequently reach its base and be reflected back on the beach resulting in scouring and a loss of material and a destabilization of the revetment. Periodic sandfill nourishment could correct this condition. Overtopping of the revetment, particularly in the Codfish Park area, may erode the area behind the revetment. Also flanking of the revetment could occur unless it were tied into the existing beach berm or bluff a sufficient distance, since there are presently no shore protection structures in the area. If the aforementioned design precautions are taken, the cost of the revetment would far exceed the benefits to the backshore properties. Revetments are, therefore, not considered further in this study.

Sandfill

Sandfill is a form of shore protection that is placed on the shore to form a wider berm so that storm waves break further offshore and minimize impacting the base of the backshore berm or bluff. Periodic nourishment is an integral part of a sandfill plan. Its purpose is to replace sand lost to littoral and offshore movement and to retain the geometric configuration and level of protection of the sandfill. A preliminary analysis indicated that sandfill protection to the Siasconset shoreline warranted more detailed study.

WITH PROJECT CONDITION

The with project condition is the most likely condition that is expected to exist during the 50-year planning horizon in the Study Area if a federally assisted project is undertaken. There are as many with project conditions as there are alternative plans and options. Again the analysis focusses on the Codfish Park area where land use is densest, coastal erosion is among the most severe and the potential benefits of measures to control erosion are greatest.

Sandfill Design

The design features are more fully discussed in Appendix C. Since sandfill protection is the only alternative that warrants further consideration, two options have been considered: one which offers protection from a 100-year recurrence event and the other a 50-year event. Since there has been over 100 feet of low scarp lost to erosion in the Codfish Park area between August 1991 and October

1993, a minimum width of berm was set at 100 feet.

The design elevation of the considered sandfill berm was obtained from the sum of the still water level (SWL), or tide level plus storm surge and wave setup (Sw) and wave runup (Ru). The result is a design berm elevation of 16.5 feet (MTL) for a 100-year recurrence event and 12.5 feet (MTL) for a 50-year event. The latter elevation would approximately match the elevation of the existing low scarp. Based on the analyses and engineering judgement a sandfill slope of 1 vertical (V) and 15 horizontal (H) was selected as more effective than the existing slope of 1V to 10 H in reducing the severity of plunging breaking waves and in minimizing the elevation of the required berm elevation necessary to control runup and overtopping.

Conditions with Sandfill

With the sandfill in place, the waves would break farther offshore and runup the face of the sandfill. The berm elevation would not be overtopped except by storms exceeding the design elevation: 16.5 feet (MTL) or 12.5 feet (MTL). During more intense storms overtopping would be substantially reduced with the sandfill in place. The improvement plans would reduce erosion and storm damages.

The sandfill improvement plans would arrest long term erosion and the loss of structures.

The improvement plans would alleviate storm damages due to wave attack and inundation only in the Codfish Park area, where properties have been constructed on the low scarp which is subject to flooding and wave action. However, substantial residual flooding and wave damages would remain. The coastal engineering analysis indicates minimal shoreline recovery after storms. Structures damaged during storms due to shoreline recession would generally not be reconstructed nor repaired substantially.

Alternative Sandfill and Costs

This study addresses the sandfill protection of the Siasconset shoreline at Segment A: Codfish Park (1,250 feet), B: Baxter/Sankaty (4,480 feet), C: Hoicks/Sesachacha (5,450 feet) and also along virtually the entire study area shoreline from Gulley Road some 14,450 feet to transect 97.

In a series of reports and a letter (2 October 1993) to the town of Nantucket's Director of Public Works, the Aubrey Consulting Company located two potential sand borrow sites containing the required quantity of beach-compatible sand for sandfill protection of the Siasconset shoreline. Borrow site #1 is located approximately 3 miles east of Sankaty Light Station and site #2 some 5 miles southeast of Codfish Park.

Sandfill volumes were calculated for the 2800 long Codfish Park improvement plans for protection from the 100 and 50-year recurrence events and extrapolated for the plans to protect other portions of the shoreline. See Table 3.

The cost estimates in Table 4 were developed for the required volumes of fill assuming that sufficient quantity is available, the borrow site is not more than six miles from the study area, the use of a hopper dredge capable of approaching the shoreline within 1,200 feet, the hydraulic discharge of the material onto the shoreline and its mechanical spreading to conform to the design configuration. Unit sandfill cost prepared by the New England Division is $8.50 per cubic yard plus mobilization and demobilization, contingencies, planning, engineering and design and construction management.

ECONOMIC EVALUATION

Methodology

The economic analysis of the alternative shore protection plans is addressed in Appendix D. The potential hurricane and storm damage reduction benefits as a result of the implementation of each plan are compared to the costs in 1994 prices of each plan. Benefits and costs are made comparable by conversion to average annual equivalents using an interest rate of 8 percent and a project economic life of 50 years. For each plan annual benefits are divided by annual costs to determine the benefit-cost ratio. This ratio must be equal to or greater than one for Federal participation in water resources improvement projects.

Results

Table 5 presents the development of the annualized costs of the sandfill improvement plans. Table 6 shows that none of the sandfill protection plans are economically feasible since the benefit-cost ratios are less than one.

Sensitivity Analysis

An analysis has been conducted to determine the sensitivity of the results to changes of a key factor in the analysis, the unit cost of sand. The sensitivity analysis indicated that, even with the least plausible unit price ($5.00 instead of $8.50), none of the sandfill alternatives would be economically justified.

Table 3
Siasconset Shore Protection Study
SANDFILL PROTECTION PLANS

Plan	Description	Length (feet)	Berm Width (feet)	Berm Elev. (feet)	Sandfill Volume (1000cy)	Periodic Nourishment (1000 cy/yr)
1	Codfish Park					
	Option 100	2,800*	100	16.5	670	20
	Option 50	"	80	12.5	400	20
	Option 100CDS++	"	100	16.5	670	10
	Option 50CDS++	"	80	12.5	400	10
2	Baxter/Sankaty					
	Option 100	6,000*	100	16.5	1,440	40
	Option 50	"	80	12.5	860	40
3	Hoicks/Sesachacha					
	Option 100	7,000*	100	16.5	1,680	40
	Option 50	"	80	12.5	1,000	40
4	Study Area					
	Option 100	16,000*	100	16.5	3,840	80
	Option 50	"	80	12.5	2,290	80

* The protective sandfill extends between 750 and 800 feet beyond the extremities of the area to be protected.

++ These options assume the installation of the Coastal Drain System (Beach Dewatering) along the Codfish Park area and that it 50 percent effective in reducing periodic nourishment.

Table 4
Siasconset Shore Protection Study
CODFISH PARK - COSTS: SANDFILL PROTECTION PLANS
(1994 Prices)

Item	Unit Price	OPTION 100 Quantity (cu yds)	OPTION 100 Cost ($1,000)	OPTION 50 Quantity (cu yds)	OPTION 50 Cost ($1,000)
Dredging/Placing/ Shaping Sandfill	$8.50/cy	670,000	5,695	400,000	3,400
Mobilization/ Demobilization			536		536
SUBTOTAL			6,231		3,936
Contingencies (15%)			935		590
SUBTOTAL			7,166		4,526
Planning, Engineering & Design (PED)			376		238
Construction Management (CM)			484		306
TOTAL			8,026		5,070

Table 5
Siasconset Shore Protection Study
ANNUAL COSTS OF SANDFILL PROTECTION PLANS
($1000)

Plan	Description	Costs	Annual Costs
1	Codfish Park		
	Option 100:		
	First Construction Cost	8,026	656
	Periodic Nourishment		240
	Total Annual Cost		896
	Option 50:		
	First Construction Cost	5,070	414
	Periodic Nourishment		240
	Total Annual Cost		654
	Option 100CDS:		
	First Construction Cost	8,026	656
	Nourishment & CDS*		210
	Total Annual Cost		866
	Option 50CDS:		
	First Construction Cost	5,070	414
	Nourishment & CDS*		210
	Total Annual Cost		624
2	Baxter/Sankaty		
	Option 100:		
	First Construction Cost	17,200	1,410
	Periodic Nourishment		480
	Total Annual Cost		1,890
	Option 50:		
	First Construction Cost	10,900	890
	Periodic Nourishment		480
	Total Annual Cost		1,370
3	Hoicks/Sesachacha		
	Option 100:		
	First Construction Cost	20,100	1,640
	Periodic Nourishment		480
	Total Annual Cost		2,120
	Option 50:		
	First Construction Cost	12,700	1,040
	Periodic Nourishment		480
	Total Annual Cost		1,520

4	Study Area		
	Option 100:		
	First Construction Cost	45,900	3,750
	Periodic Nourishment		960
	Total Annual Cost		4,710
	Option 50:		
	First Construction Cost	29,000	2,370
	Periodic Nourishment		960
	Total Annual Cost		3,330

* Annualized costs of periodic nourishment and of the Coastal Drain System (CDS) assume that the CDS is 50 percent effective in reducing periodic nourishment. Costs of monitoring during the first several years after the installation of the CDS are not included.

NOTE: First construction costs have been amortized at 8 percent over a 50 year period of analysis.

Table 6
Siasconset Shore Protection Study
ECONOMIC ANALYSIS

Plan	Description	Annual Benefits ($1,000)	Annual Costs ($1,000)	Benefit/ Cost Ratio
1	Codfish Park			
	Option 100	299	896	0.33
	Option 50	294	654	0.45
	Option 100 CDS	299	866	0.34
	Option 50 CDS	294	624	0.47
2	Baxter/Sankaty			
	Option 100	623	1,890	0.33
	Option 50	623	1,370	0.45
3	Hoicks/Sesachacha			
	Option 100	415	2,120	0.20
	Option 50	415	1,520	0.27
4	Study Area			
	Option 100	1,338	4,710	0.28
	Option 50	1,333	3,330	0.40

CHAPTER 5: FINDINGS AND DETERMINATION

This Section 103 Reconnaissance Study concludes that the considered plans to control erosion in the Siasconset Study Area are not economically justified.

There is a chronic erosion problem along the eastern shore of Nantucket in the area known as Siasconset. Various alternative corrective measures were formulated and evaluated. None of the plans examined would generate benefits in excess of costs. The benefit-cost ratios for the alternatives that were examined ranged from 0.2 to 0.5 or considerably less than the required benefit-cost ratio of 1.0. I have therefore determined that there is no opportunity for Corps of Engineers' assistance in Siasconset and work is terminated with this report.

_____
Date

_____
Colonel, Corps of Engineers
Division Engineer

CHAPTER 6: ACKNOWLEDGEMENTS

The New England Division, U.S.Army Corps of Engineers prepared this report under the direction of Colonel Brink P. Miller, Division Engineer. It was prepared by Mr. Charles L. Joyce, Project Manager, under the supervision of Mr. John T. Smith, Chief Coastal Development Branch, Mr. Paul E. Pronovost, Chief, Plan Formulation Division and Mr. Joseph L. Ignazio, Director of Planning, using input from study team members.

Study Team Members included:

Mr. Edmund J. O'Leary, Jr. - Economic Analysis
Mr. Marcos Paiva - Historic and Archaeological Resources
Mr. Larry Oliver - Environmental Resources
Mr. Albert H. Lemire - Coastal Engineering
Ms. Rose Schmidt - Geotechnical Engineering
Mr. John Yen - Cost Engineering
Mr. Townsend Barker - Hydrologic and Hydraulic Analysis
Ms. Maureen McCabe - Real Estate
Mr. Edward J. Fallon - Real Estate

This report wad prepared for publication by Ms. Kristina Reitz.

Special thanks are extended to The Siasconset Beach Preservation Fund (SBPF), Inc. and its Chairman, Mr.F. Helmut Weymar and a consultant to the SBPF, Dr. Franklin Fessenden, Ph.D. for their cooperation and assistance during the course of the study.

II APPENDICES

Appendix A
Siasconset Beach, Nantucket, Massachusetts
Section 103-Environmental Reconnaissance Report

Environmental Resources Branch
New England Division
US Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

I. Project Description:

At this stage there is no recommended plan. However, for the purposes of this reconnaissance investigation a plan to provide protection to the backshore bluff involving sandfill from an offshore source with periodic renourishment and the innovative technology of beach dewatering are considered. See the main report for a description of the project and beach dewatering.

II. Environmental Setting:

General.

Siasconset Beach is located on the southeast side of the island of Nantucket (Figure 1). The shoreline is about 14,000 feet in length and is exposed to the open ocean from the east. There are about 6,000 feet of low bluff to the south and about 8,000 feet of high bluff to the north. The low bluff is about 5-15 feet high and is backed by a low, flat shelf that extends to a higher secondary bluff. The southern portion of this shelf supports many homes surrounded by predominantly coastal shrub vegetation. To the north of this developed area, vegetation on the low shelf consists mainly of beach grass (Ammophila breviligulata) with scatered pines. The high bluff which is about 100 feet above the ocean is lined with homes. Sankety Light is on the high bluff and a beach club is present at Hoicks Hollow.

Intertidal Habitats and Wetlands.

Siasconset Beach is a high energy sand beach facing the Atlantic Ocean. Three benthic core samples were collected in the lower intertidal zone at intervals along the shoreline on February 18, 1994. Due to the time of year of sampling, no organisms were found in analysis of subsamples of these cores; therefore only general observations about the shoreline benthic community can be made. The benthic community characteristic of this type of habitat consists of species adapted to a high energy, dynamic environment; therefore, the impacts of a beachfill project on the benthic community are anticipated to be minor and temporary. Some of the species characteristic of this environment are surf clams (Spisula solidissima), Pseudohaustorius spp. amphipods, and Spionid polychaetes.

Siasconset Beach is a potentially important habitat for shorebirds, such as plovers, sandpipers, gulls, and terns. The portion of Siasconset Beach between the sewage plant and just south of the point where Polpis Road changes in orientation from north-south to northwest-southeast is listed in the 1977 atlas of colony nesting waterbirds as a nesting site for least terns with 125 nesting pairs (Figure 2). The Atlantic Coast Ecological Inventory (USFWS, 1980) lists a portion of this section of beach as a least tern nesting area. Another colony with five nesting pairs was listed on the beach beside Sesachacha Pond. Recent coordination with the US Fish and Wildife Service indicates that piping plovers may be present just south of the project area. (See Endangered Species

Section of this report.) Continued coordination will be required with the Fish and Wildlife Service and appropriate state agencies to avoid impacts to these resources.

Sesachacha Pond, a large enclosed water body, is located at the northern end of the study area. It is classified as Estuarine-subtidal-open water on the U.S. Fish and Wildlife Service, National Wetlands Inventory maps. The inlet is presently closed to the ocean. In its present state of separtion from the Atlantic Ocean it could be classified as Lacustrine-littoral-tidal-unconsolidated bottom under the U.S. Fish and Wildlife Service wetands classification system (Cowardin et al., 1979). The Massachusetts Division of Marine Fisheries and National Marine Fisheries Service indicated that the Town and State physically open the former inlet to Sesachacha Pond to tidal flushing twice a year in an effort to restore anadromous fish and oyster populations. The pond is listed as a habitat for eastern oysters (Crassostrea virginica) and soft-shelled clams (Mya arenaria) in the Atlantic Coast Ecological Inventory (USFWS, 1980). The effects of additional sand in the system on the inlet to this pond should be considered in the Feasibility Phase.

Deepwater Habitats and Aquatic Resources.

Due to time of year constraints, no biological sampling of the benthic community of the offshore borrow site was conducted for this reconnaissance effort, so only general observations can be made. The subtidal benthic community at the borrow site and the shoreline benthic community will be documented during the Feasibility Phase. However, a general charaterization of the offshore benthic community can be made based on examination of the beach wrack. Evidence of the following organisms was recovered in the wrack on 18 February 1994: palmate sponge (Isodictya sp.), fig sponge (Suberites sp.), skate (Raja sp.), whelk (Busycon sp.), eelgrass (Zostera marina), kelp (Laminaria sp.), rockweed (Fucus vesiculosus), sea lettuce (Ulva lactuca), chenille weed (Dasya pedicellata), and the green seaweed, Spongomorpha sp. These species may be present in the nearshore waters adjacent to the beach.

The Atlantic Coast Ecological Inventory (USFWS, 1980) lists scup (Stenotomus chrysops), black sea bass (Centropristis striata), and Atlantic mackeral (Scomber scombrus) as ocean species of recreational and commercial importance in the mid-Atlantic region. Other recreationally important finfish that may use the nearshore area for feeding include striped bass (Morone saxatilis) and bluefish (Potmatomus saltatrix). Finfish are a concern during dredging and renourishment because they may be affected by physical disturbance to habitat and turbidity. The Division of Marine Fisheries indicated that potential temporary effects on surf fishing should be considered in the project evaluation (G. Skomal, Division of Marine Fisheries, telephone communication, 17 February 1994).

The coastal waters near Siasconset Beach are used by seaducks and diving ducks. American eider (Somateria mollissima dresseri), white-winged scoters (Malanitta fusca deglandi), bufflehead (Bucephala albeola), and goldeneye (Bucephala sp.) were observed during the 18 February site visit. American

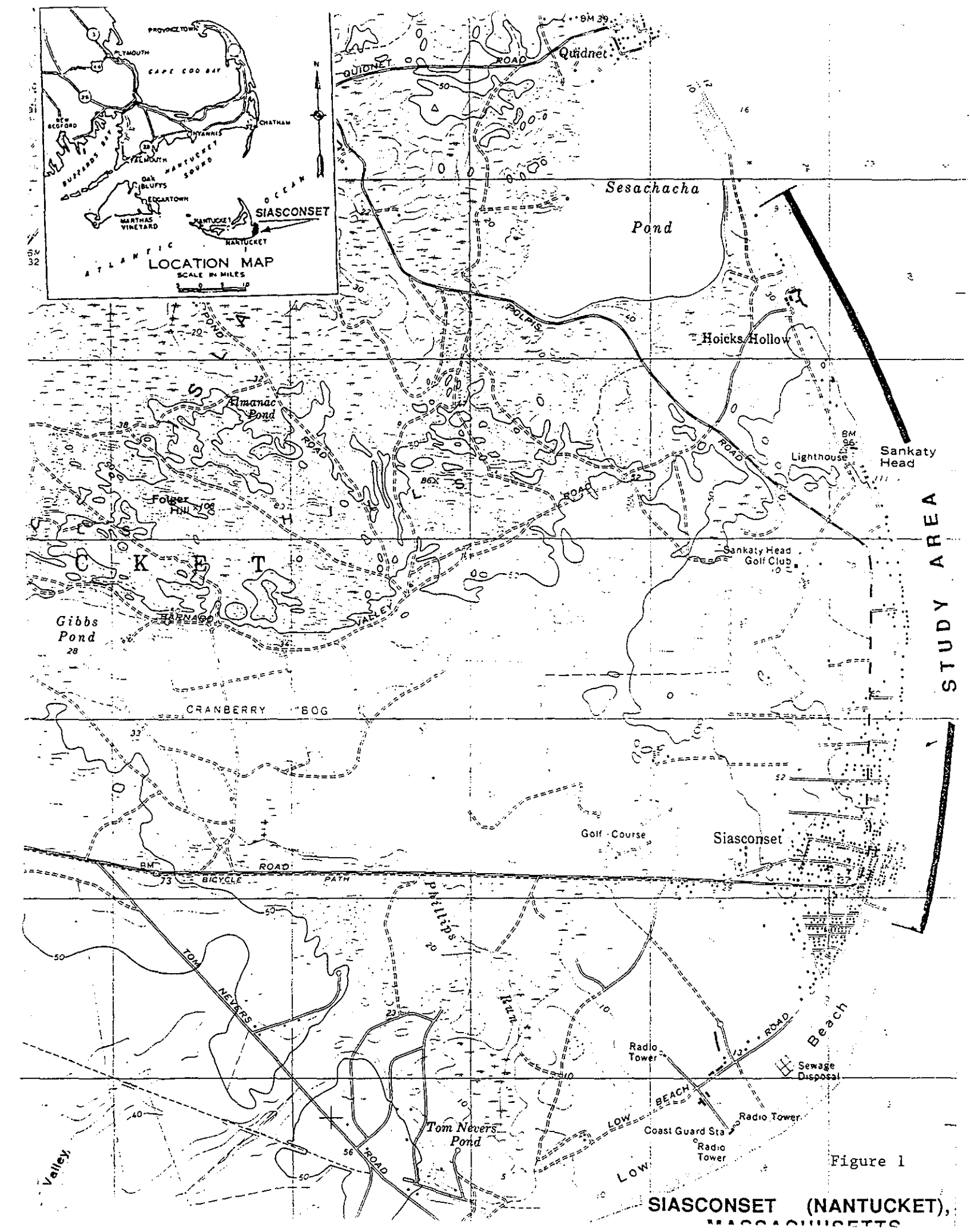
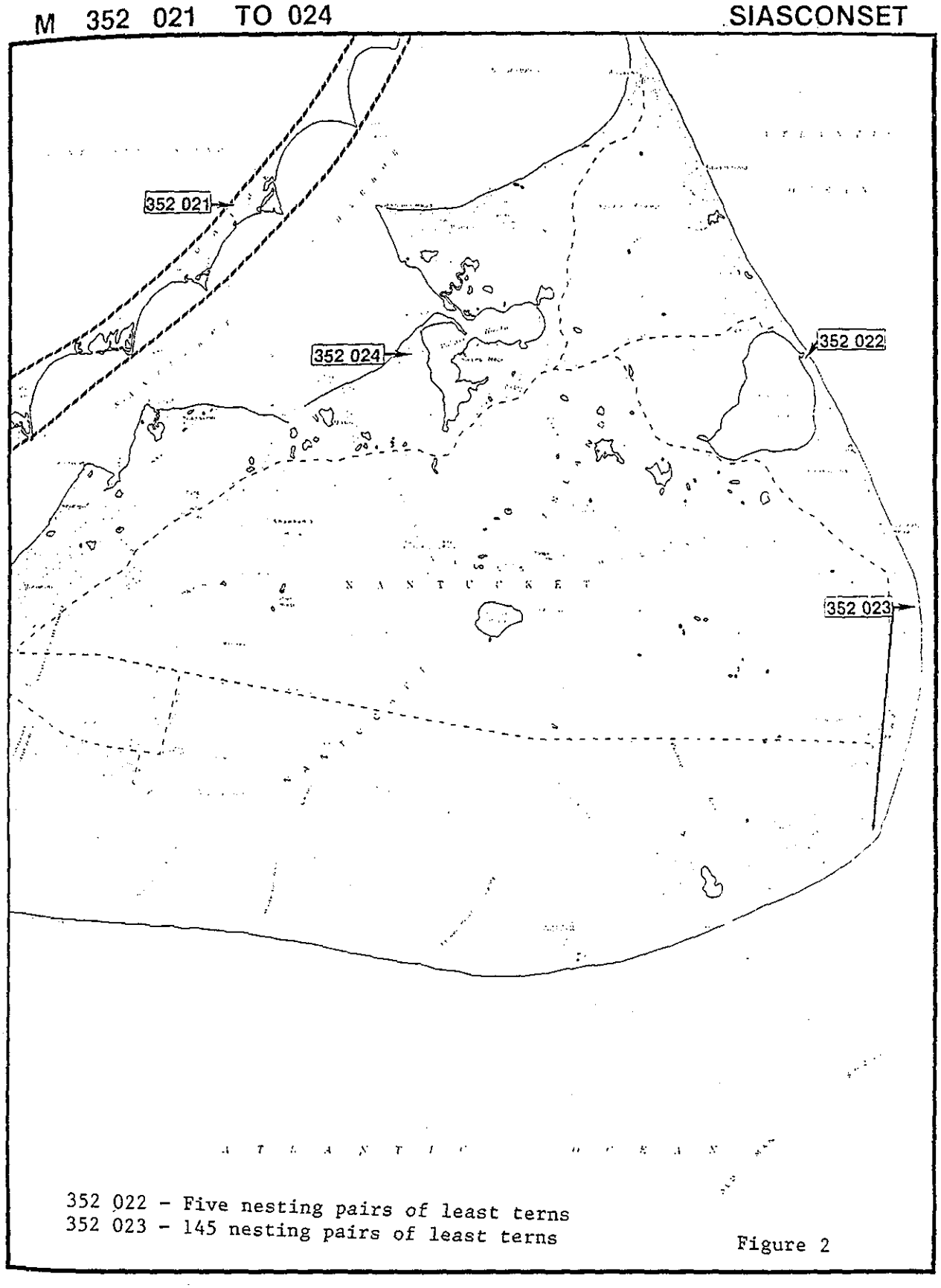


Figure 1

SIASCONSET (NANTUCKET),



352 022 - Five nesting pairs of least terns
352 023 - 145 nesting pairs of least terns

Figure 2

eider were the most abundant species observed with concentrations in the hundreds within about 1,000 feet of the shore and within sight distance. They were most abundant at the southern end of the study area in the vicinity of offshore shoals. Preliminary coordination with Mr. H.W. Huesmann, the Massachusetts Division of Fisheries and Wildlife waterfowl biologist, indicates that, in addition to common eider and scotors, the deeper waters off Nantucket serve as resting areas for oldsquaw (Clangula hyemalis). Oldsquaw can dive to well over one-hundred feet and feed on crustaceans, particularly amphipods and crabs, mollusks, insects, fish, and plants (Belrose, 1976). Eiders dive from 20-30 feet (H.W. Huesmann, pers. comm., March 1994) and feed primarily on mollusks, especially blue mussels (Mytilus edulis), as well as crustaceans (amhipods, isopods, and crabs) (Bellrose, 1976). Effects on wintering waterfowl should be evaluated in the environmental assessment.

Coastal Dune Habitats.

The scarp extending to a higher secondary bluff along the southern end of the project area is backed by a low, flat shelf. The southern portion of this shelf supports many homes surrounded by predominantly coastal shrub vegetation. To the north of this developed area, vegetation on the low shelf consists mainly of beach grass with scatered pines. Dunes are important as a system for storing sand to be provided to eroding beaches and as protection to features located behind them. Although low in productivity because of the environmental stresses they endure, they provide valuable habitat for a number of species (Woodhouse, 1982). They provide cover and nesting habitat for shorebirds, song birds, and gulls and terns and cover and forage areas for mammals. Impacts to dune vegetation should be minimized.

Threatened and Endangered Species.

Coordination with the U.S. Fish and Wildlife Service indicated a potential for the presence of piping plovers. The Fish and Wildlife Service indicates that based on currently available information the Federally threatened Altantic coast piping plover (Charadrius melodus) is known to occur immediately south of the project area. They recommend that beach erosion control activitites take place between September 15 and April 1. If beach nourishment cannot occur within this window they recommend a survey of the project area prior to project activities to determine whether piping plover have established breeding territories or are nesting (Correspondence dated February 28, 1994).

Information from the National Marine Fisheries Service on threatened and endangered species had not been received at the time of completion of this report. The letter will be attached to this report as soon as it is received.

Historic and Archaeological Resources

The study area for the Siasconset shore protection study extends from the eastern edge of Sesachacha Pond along the coast to just south of the area known as Codfish Park. The approximately 14,000 feet of coastline can be characterized by varying conditions from north to south. In the Codfish Park area, densely constructed homes have been built in a low lying dune area which fronts a large bluff. Here several homes have been lost to coastal storms over the past several years. Moving north, the low level dune gradually gives way to a high bluff area on which larger, more expensive homes have been built. The Sankaty Head lighthouse, a National Historic Landmark, is also located in this vicinity.

The American whaling industry originated on Nantucket Island late in the 17th Century, and flourished uninterrupted until the 1840's when the nearby port city of New Bedford commanded the trade. Settlers basically followed the example of the original Native American inhabitants. Today, Nantucket is the finest surviving example of a late 18th and early 19th Century seaport town. Evidence of the whale trade is preserved in early whaling stations located along the coast, particularly in Siasconset dating from 1660-1670, together with accompanying settlements. In all, Nantucket remains basically unchanged from this period and retains the ambience and character of the early whaling industry in New England (National Register of Historic Places Inventory/Nomination Form, Nantucket Island, 1975).

A review of resources at the Massachusetts Historical Commission as well as at NED have revealed many historic and archaeological resources in the vicinity of the project area. Various prehistoric archaeological sites are documented close to the study location. Most of these are findspots which consist of a single artifact and are not considered culturally significant. A large prehistoric site, 19-NT-49, located along the eastern and southeastern shores of Sesachacha Pond, may be within the northern limit of the study area; however, it is difficult to determine with certainty. No other information was available about this site, as well as 19-NT-59, which is located inland to the west of the project. The Sesachacha Pond area contains numerous prehistoric archaeological sites around its perimeter, indicating a location of prime importance to prehistoric peoples.

A total of three historical archaeological sites are documented near the study area. However, all are located a safe distance from the shore and the proposed undertaking. Historic resources were in abundance throughout the project. The Early Modern Period (1915-present) is represented by resources from just south of the Sankaty Head Lighthouse to the northern half of the Siasconset town area, consisting probably of the road network. The Late Industrial Period (1870-1915) is indicated from Milestone Road south and along Beach Road, including an abandoned railroad grade. The Early Industrial Period (1830-1870) is represented by the Sankaty Head Lighthouse which dates from 1849, and is a National Historic Landmark on the National Register of Historic Places. Finally, the Federal Period (1775-1830) is indicated by a variety of properties adjacent to the Codfish Park area where most structures were built during this era.

It should be noted that the entire island of Nantucket has been designated a National Register Historic District and National Historic Landmark. The only National Register property within the vicinity of the proposed project appears to be the Sankaty Head Lighthouse, a National Historic Landmark. The National Register nomination form for the island of Nantucket indicates three historic structures within the town of Siasconset: Auld Land Syng which dates from 1676, and Rose Cottage and Shanunga, both of which date from approximately 1682 (National Register of Historic Places Inventory/Nomination Form, Nantucket Island, 1975, page 2). These properties are not listed on the National Register and it is not known if they still exist in these locations.

III. Coastal Zone Management Program Consistency.

The preliminary review of the policies of the Approved Massachusetts Coastal Zone Management Program reveals that the key considerations will be related to Policies 1, 4, 5, and 17 (see attached evaluation). Sufficient information must be generated during the Feasibility Phase to address these policies. In particular, marine ecological productivity, longshore transport of sediment, construction of dewatering infrastructure, and the effects of the borrow site on wave refraction must be addressed.

IV. Opinions.

Beach Nourishment.

Placement of material at Siasconset Beach is unlikely to have any severe impacts, provided that the dredged material is low in fines, compatible with the native beach material and construction is timed to avoid effects on piping plovers.

The most important concern identified relative to ecological effects of placement of sand on the beach is the potential to affect piping plovers. The US Fish and Wildlife Service recommends beach erosion control activities be timed to avoid the September 15 through April 1 time frame or that a survey be conducted to determine whether breeding or nesting territories have been established. Beach disposal can benefit piping plovers when timed properly.

We have not received information on threatened and endangered species from the National Marine Fisheries Service yet.

The effects of the beach nourishment on aquatic organisms are not expected to be severe. Sampling of the benthic community on the beach face conducted in February of 1994 did not provide information useful for developing a sampling plan for the environmental assessment or to describe the benthic community. Sampling will be conducted during the spring-summer-fall to characterize the benthic community for the Environmental Assessment. Due to the type of habitat, benthic invertebrate sampling is not anticipated to reveal any species that would be significantly impacted by the nourishment project.

The National Marine Fisheries Service and the Massachusetts Division of Marine Fisheries indicated that the environmental assessment should consider effects of beach nourishment on the inlet opening at Sesachacha Pond. If the width of the beach increases, the environmental assessment should consider whether the change affects the feasibility or cost of the inlet opening operation.

Borrow Area Dredging.

No sampling has been conducted yet in the subtidal borrow areas. Based on comments from the Massachusetts Division of Marine Fisheries, shellfish may be present in the borrow area waters. The composition of the beach wrack suggests that eelgrass may also be present in the nearshore waters. Sampling would be conducted for the environmental assessment to determine the presence and significance of these and other resources. Communities that would be a major concern are eelgrass beds, shellfish, or exceptionally high densities or unique assembleges of benthic invertebrates. In addition, the benthic community is important as a food source for wintering waterfowl at this site. Mitigation for impacts to these resources would consist of avoiding and minimizing the impact and replanting.

Coordination with the Massachusetts Division of Fisheries and Wildlife during the environmental assessment phase will be required to determine the potential of the project to affect wintering populations of waterfowl. Concentrations of common eider were observed during the coordinated site visit and preliminary coordination with the division's waterfowl biologist indicates that the waters off Nantucket are important wintering areas for oldsquaw, eiders, and scoters. The project could affect wintering waterfowl through disturbance associated with dredging pipelines and direct removal of feeding habitat. The severity of impacts to these species will depend on the depth and location of the borrow areas (H.W. Huesmann, pers. comm., March 1994), the composition and productivity of the benthic community affected, density of waterfowl at the site, and the time of construction. Our Fish and Wildlife Coordination Act letter to the Division of Fisheries and Wildlife should mention wintering waterfowl.

Impacts to water quality and fish populations will probably not be a major concern. Because of the open coast location, fish can avoid the project area.

Beach Dewatering.

The major concern with beach dewatering is whether it will reduce longshore littoral transport of sediment. The effect of dewatering on longshore transport will affect its consistency with the Massachusetts Coastal Zone Management Program.

The temporary construction phase effects of installation of beach dewatering infrastructure and its maintenance are a concern of the Nantucket Conservation Commission. Any destruction of vegetation on the the dunes will

require replanting. Excavation of the beach to install beach dewatering infrastructure would temporarily disturb the benthic community and increase suspended solids, but, as with renourishment, the open coastal location should serve to minimize the significance of these effects. The environmental assessment should also consider whether the change in the habitat that will occur with dewatering will affect the benthic community along the shore.

Historic and Archaeological Resources.

A review of shipwreck files located approximately 150 documented wrecks in the vicinity of Nantucket and the project area. About 6 of these were identified within the area of Siasconset. Any offshore location selected for sandfill material, as well as locations for pumps and piping along the shore associated with the dewatering technology would have to be evaluated for historic or archaeological resources.

Currently, the only resource which may be affected by the proposed project is archaeological site 19-NT-49 for which no information was available within the site files. This prehistoric site, along the eastern edge of Sesachacha Pond, may be partially within the study area, and like other sites around the pond, may be culturally significant. This is a preliminary investigation. If this project proceeds further in the planning process, then a detailed protection plan will be formulated. At that time, this final plan will be evaluated for its effect upon cultural resources and formal comments will be requested from the Massachusetts State Historic Preservation Officer (MA SHPO) to satisfy Section 106 of the National Historic Preservation Act of 1966, as amended. The Massachusetts SHPO is expected to concur with these determinations.

Complinace with Environmental Regulations.

In general, beach nourishment is consistent with the Massachusetts Coastal Zone Mangement Program. Preliminary coordination with the Massachusetts Office of Coastal Zone Management (MCZM) (O'Connell, J., MCZM, pers. comm., March 1994) indicates that, in addition to the evaluation of effects on ecological resources related to the borrow area and renourishment locations, the placement of pumps and related structures are a main focus of concern. In general, MCZM supports the use of beach dewatering as an experimental technology. Effects on longshore transport are not anticipated to be severe because, although the system will retain sand, transport will not be blocked and longshore transport can continue.

The Massachusetts Wetlands Protection Act regulations allow beach nourishment with clean sediment of a grain size compatible with that on the existing beach and coordination with the Nantucket Conservation Commission did not reveal any particular concerns with beach nourishment.

V. Cost Estimate for Environmental Work

The preliminary estimate for environmental input is $31,000. This estimate includes costs of the following tasks:

Site visits
Benthic invertebrate sampling and analysis
Coordination
Prepare an Environmental Assessment and FONSI
Prepare 404(b)(1) Evaluation
Prepare and submit Conditional Water Quality Certification request and preliminary CZM Consistency Determination
Fish and Wildlife Coordination Act Transfer ($4,000)
Contingencies, review, and response to comments
Historic and Archaeological Resources Compliance ($5,000)

VI. References

Bellrose, F.C. 1980. Ducks Geese and Swans of North America. Stackpole Books, Harrisburg, PA.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Washington, D.C. FWS/OBS-79/31

Erwin, R.W. and C.E. Korschgen. 1979. Coastal waterbird colonies: Maine to Virginia. 1977. An atlas showing colony locations and species composition. U.S. Fish and Wildlife Service, Biological Services Program, FWS/OBS-79/08.

Massachusetts Department of Environmental Quality Engineering. 1987. Wetlands Protection Act Regulations. Commonwealth of Massachusetts.

Massachusetts Historical Commission. 1975. National Register of Historic Places Inventory-Nomination Form, Nantucket Historic District, Boston, MA. Form prepared by Patricia Heintzelman, Historic Sites Survey, National Park Service, Washington, D.C.

U.S. Fish and Wildlife Service. 1980. Atlantic coast ecological inventory. Biological Services Program. Washington, D.C.

Woodhouse, W.W. Jr. 1982. Coastal sand dunes of the U.S. in Creation and Restoration of Coastal Plant Communities, R.R. Lewis III editor, CRC Press, Inc., Boca Raton, FL.

Attachment 1
Initial Coastal Zone Management Program
Policy Review

Preliminary Evaluation of Coastal Zone Mangement Policies
Beach Renourishment Alternative, Siasconset Shore Protection
Section 103, Reconnaissance Investigation

Policy 1. Protect ecologically significant resource areas (salt marshes, shellfish beds, dunes, beaches, barrier beaches, and salt ponds) for their contributions to marine productivity and value as natural habitats and storm buffers.

Consistency. The proposed beach erosion control project is expected to have minor ecological effects on the high energy beach and will enhance its value as a storm buffer. Consistency with this policy will in all likelihood be achieved.

Policy 2. Protect complexes of marine resource areas of unique productivity (Areas for Preservation or Restoration (APRs)/Areas of Critical Environmental Concern (ACECs)); ensure that activities in or impacting such complexes are designed and carried out to minimize adverse effects on marine productivity, habitat values, water quality, and storm buffering of the entire complex.

Consistency. The project is not located within an APR or ACEC.

Policy 4. Condition construction in water bodies and contiguous land areas to minimize interference with circulation and sediment transport and to preserve water quality and marine productivity. Approve permits for flood control projects when it has been determined that there will be no significant adverse effects on the project site or adjacent downcoast areas.

Consistency. Consistency with this policy will depend on whether the beach dewatering component will significantly affect downcoast sediment transport. The significance of this effect appears to be the key element in the consistency determination. Preliminary coordination with the Massachusetts Office of Coastal Zone Management (MCZM) (O'Connell, J., MCZM, pers. comm., March 1994) indicates that, in general, MCZM supports the use of beach dewatering as an experimental technology. (The placement of pumps and related structures is a concern.) Effects on longshore transport are not anticipated to be severe because, although the system will retain sand, transport will not be blocked and longshore transport can continue.

Due to the high energy, open coastal location of the project, effects on water quality and marine productivty should be minor.

Policy 5. Ensure that dredging and disposal of dredged material minimize adverse effects on water quality, physical processes, marine productivity and public health.

Consistency. Because of the high energy, open coast site; the large grain sizes that will be necessary for project stability, and the resiliance of the open coast benthic community, it is unlikely that the project will have adverse effects on water quality, marine productivity, and public health. The effect of the borrow site excavation on shoreline physical processes must be considered.

Policy 7. Encourage the location of maritime commerce and development in segments of urban waterfronts designated as port areas. Within these areas, prevent the exclusion of maritime dependent industrial uses that require the use of lands subject to tidelands licenses.

Consistency. This project does not affect the location of maritime commerce or urban waterfronts.

Policy 10. All development must conform to existing applicable state and federal requirements governing sub-surface waste discharges, sources of air and water pollution and protection of inland wetlands.

Consistency. The project does not involve subsurface waste discharge or inland wetlands. The project is expected to conform with applicable state and federal requirements governing sources of air and water pollution without any special considerations. An evaluation will be conducted to ensure compliance with the Section 404 (b)(1) Guidelines of the Clean Water Act and an applications for conditional and final Section 401 Water Quality Certification will be submitted to the Massachusetts Division of Water Pollution Control.

Policy 11. Protect designated scenic rivers in the coastal zone. Support designation of areas for preservation and restoration as "sign free areas".

Consistency. The project will not affect scenic rivers; nor does it involve APRs or signs.

Policy 12. Review proposed developments in or near designated or registered historic districts or sites to ensure that federal, state, and private actions requiring a state permit respect their preservation intent and minimize potential adverse impacts.

Consistency. The project effects on historic or prehistoric resources will be evaluated.

Policy 13. Review developments proposed near existing public recreation sites to minimize their adverse impacts.

Consistency. The project has the potential for temporary effects on recreational use of the beach during the construction period. Recreational use of the beach should be considered in the Feasibility Phase.

Policy 17. Provide funding for protection from tidal flooding and erosion, emphasizing the use of non-structural measures where feasible.

Consistency. The project provides protection from flooding and erosion and involves non-structural measures.

Policy 19. Promote the widest possible public benefit from channel dredging, ensuring that designated ports and developed harbors are given highest priority in the allocation of federal and state dredging funds. Ensure that this dredging is consistent with marine environmental policies.

Consistency. Not applicable. This project does not involve channel dredging.

Policy 24. Expand existing recreation facilities and acquire and develop new public areas for coastal recreational activities. Give highest priority to expansion or new acquisitions in regions of highest need or where site availability is now limited. Assure that both transportation access and the recreational facilities are compatible with social and environmental characteristics of the surrounding communities.

Consistency. The beach must be available for public use if the Federal project is implemented.

Attachment 2
Environmental Coordination
and Correspondence

Oliver

January 13, 1994

Planning Directorate
Impact Analysis Division

Mr. Gordon Beckett, Supervisor
Fish and Wildlife Service
400 Ralph Pill Building
22 Bridge Street
Concord, New Hampshire 03301-4901

Dear Mr. Beckett:

The U.S. Army Corps of Engineers is conducting a reconnaissance Section 103, Beach Erosion Control study, at Siasconset Beach in Nantucket, Massachusetts. The study area includes approximately 3 miles of beachfront between Siasconset and the southern end of Sesachacha Pond. (See attached map.) A recommended plan may encompass only a portion of this study area.

We are studying the possibility of placing sand from an offshore source on the beach with dewatering of the beach face to increase retention of sand.

A site visit for environmental organizations is scheduled for February 18, 1994 at 11:00 a.m. at the corner of Gully Road and Codfish Park Road. A brief description of the project will be presented. This meeting will provide an opportunity for comment and exchange of information on the project.

We would also appreciate any written comments your agency may have. Please contact Mr. Larry Oliver of my staff, if you cannot send a representative to the site visit or if you have questions about this project.

Sincerely,

Joseph L. Ignazio
Director of Planning

SAME LETTER SENT TO:

Mr. Philip G. Coates, Director
MA Division of Marine Fisheries
100 Cambridge Street
Boston, Massachusetts 02202

Mr. Thomas Bigford
NOAA-Fisheries
1 Blackburn Drive
Gloucester, Massachusetts 01930

Mr. Brian Donahoe, Director
Dept. of Environmental Protection
Division of Water Pollution Control
One Winter Street
Boston, Massachusetts 02108

Mr. Gorden Beckett, Supervisor
U.S. Fish and Wildlife Service
400 Ralph Pill Building
22 Bridge Street
Concord, New Hampshire 03301

Mr. Scott Hecker
Massachusetts Audubon Society
South Great Road
Lincoln, Massachusetts 01773

Mr. Dave Shepardson
MEPA Unit
100 Cambridge St., 20th Floor
Boston, Massachusetts 02202

Ms. Christy Foote-Smith
Mass. Dept. of Environ. Prot.
Division of Wetlands/Waterways
One Winter Street
Boston, Massachusetts 02108

Mr. Daniel Greenbaum, Commissioner
Mass. Dept. of Environmental Prot.
One Winter Street
Boston, Massachusetts 02108

Mr. Eugene Cavanaugh, Director
Mass. Bureau of Coastal Engineering
100 Cambridge Street
Boston, Massachusetts 02202

Mr. ~~Donald~~ Dawn Darby
Nantucket Land Bank Commiss.
22 Broad Street
Nantucket, Massachusetts 02554

Mr. Jim Lentowski
Nantucket Conservation Found. Inc.
118 Cliff Road
P O Box 13
Nantucket, Massachusetts 02554

Mr. Charles Millen
Department of Natural Resources
1189 Phinney's Lane
Centerville, Massachusetts 02632

Mr. Douglas Thompson
Chief, Wetlands Protec. Section
U.S. Environmental Prot. Agency
JFK Federal Building
Boston, Massachusetts 02203

Mr. Jeffrey Willet, Superintendent
Department of Public Works
Town & County Building
P O Box 239
16 Broad Street
Nantucket, Massachusetts 02554

Ms. Pamela Rubinoff
Mass. Coastal Zone Management
3225 Main Street, Box 226
Barnstable, Massachusetts 02630

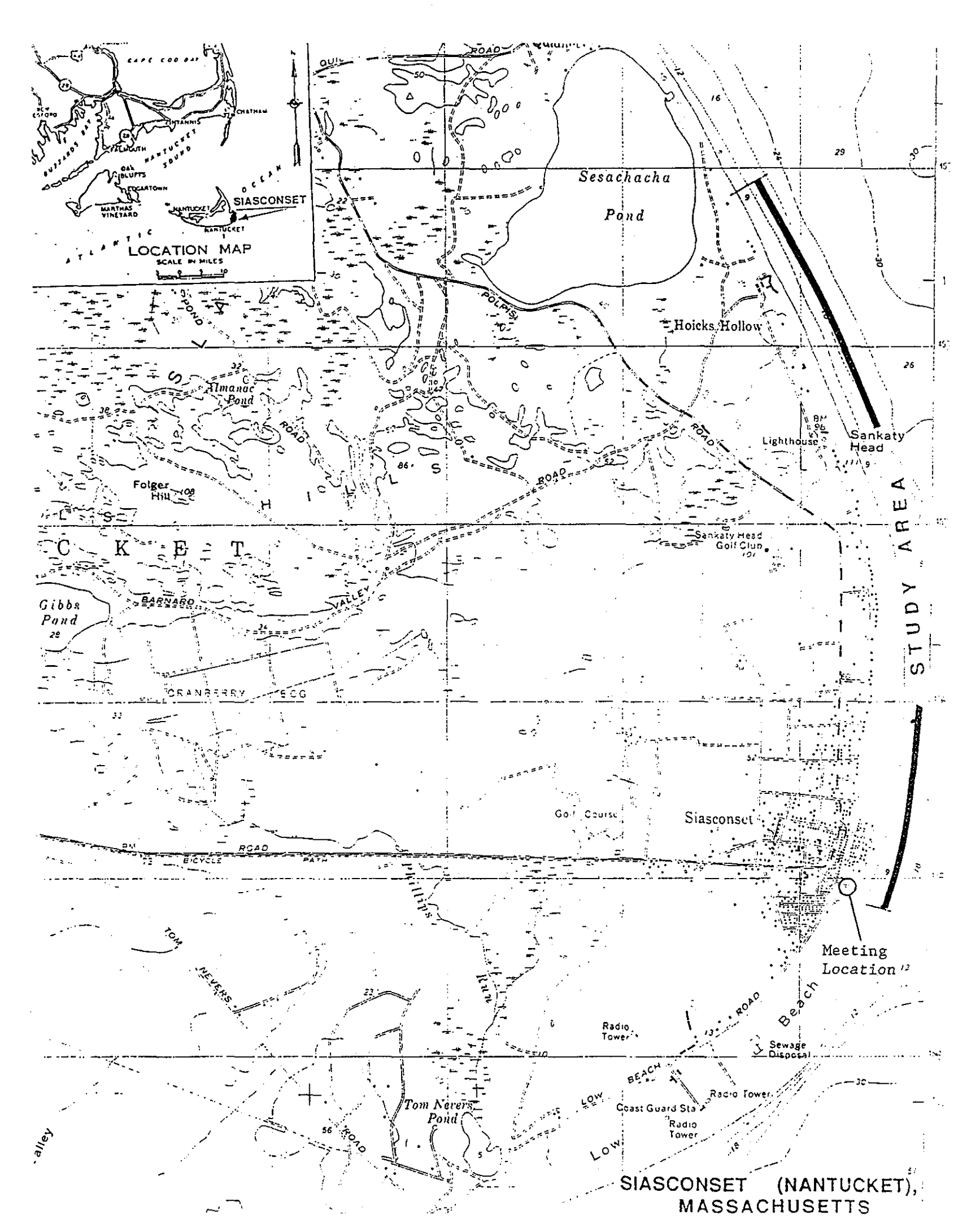
Mr. Wayne F. Holmes, Chairman
Board of Selectmen
Town of Nantucket
Town & County Building
Nantucket, Massachusetts 02554

Ms. Margaret Brady, Acting Director
Mass. Coastal Zone Management
100 Cambridge Street
Boston, Massachusetts 02202

Mr. Bruce Perry, Administrator
Nantucket Conservation Commission
Town & County Building
16 Broad Street
Nantucket, Massachusetts 02554

Mr. F. Helmut Weymar, Chairman
Siasconset Beach Preservation Found, Inc.
80 Wescott Road
Princeton, New Jersey 08540

Mr. David Fronzuto
Nantucket Shellfish and Marine Dept.
Town & County Building
16 Broad Street
Nantucket, Massachusuetts 02554


LOCATION MAP
SCALE IN MILES
SIASCONSET
NANTUCKET
ATLANTIC OCEAN
Sesachacha Pond
Hoicks Hollow
Almanac Pond
Folger Hill
Lighthouse
Sankaty Head
Sankaty Head Golf Club
STUDY AREA
Gibbs Pond
CRANBERRY BOG
Golf Course
Siasconset
BICYCLE PATH
Meeting Location
Tom Nevers Pond
Radio Tower
Sewage Disposal
Coast Guard Sta
Radio Tower
SIASCONSET (NANTUCKET), MASSACHUSETTS

MEMORANDUM FOR THE RECORD

SUBJECT: Siasconset Beach, Section 103 Study - Coordinated Site Visit

1. Date of Meeting: 18 February 1994

2. Location: Siasconset Beach, Nantucket, Massachusetts

3. Participants: See attached sheet

4. Report: The coordinated site visit was held at the southern end of the project site at the end of Gulley Road. Only the representatives of local organizations and the representative of the State sponsor (Mass DEM) attended the meeting. Since the local representatives were familiar with the area we did not tour the project site as a group. I described the purpose of the coordinated site visit and the general study phases. Mr. Joyce described the project.

The related beach dewatering project was the subject of the Nantucket Conservation Commission meeting held on 17 February 1994. The Conservation Commission representatives described their concerns with the beach dewatering effort. (Beach dewatering may be a component of the Federal project.) Their concerns are: How will maintenance be handled? Will dewatering cause downdrift starvation of the beach? and Where will the infrastructure including electrical supply be located? They indicated that a sandbag component was eliminated from the local plan early in the MEPA process.

They have only general questions about sandfill such as how long it will last and the effects on the offshore area of removing sand. They have no particular concerns with it. Dr. Tiffany of the University of Massachusetts, Nantucket Field Station emphasized the importance of the nearshore shoals on the beach dynamics. (The present borrow area is located well seaward of the shoals.)

After the meeting we toured the project area with Leslie Lewis of MDEM. The southern portion of the project site has a low primary berm and shelf in front of a high secondary bluff. The lower shelf has accreted relatively recently and has many homes on it. The vegetation is primarily shrubs typical of the coastal environment along the more southerly portion, with beach grass dominant toward the north. There were hundreds of common eider, tens of white-winged scoter, and a few bufflehead using the the nearshore zone between the beach and shoals.

At Sankaty Light to the north the high bluff directly abuts the beach with no vegetation between the face of the bluff and the beach. Common eider were less abundant here but still in the hundreds. A few goldeneye were also present. All of the waterfowl appeared to be within about one-thousand feet of the shore.

At Hoicks Hollow the high bluff is still present. Common eider were less abundant and two white-winged scoters were present within about 800-900 feet of the shore.

The bluff tapers out at Sesachacha Pond. The inlet was not open at the time of this site visit.

5. Importance to NED: This site visit provided an early opportunity for interested agencies to view the project site. No Federal or State agencies with the exception of the local sponsor attended. The comments of the agencies that attended did not reveal any significant, unexpected concerns. Winter waterfowl use of the nearshore zone (especially common eider) was heavy.

LARRY OLIVER
Biologist

cc: Mr. Hubbard
Mr. Joyce
IAD Files

SIGN IN SHEET 2/19/94

SIASCONSET SECTION 103 SITE VISIT

Frank Fessenden	Siasconset Beach Preservation Fund	508-428 8618 617-891-2262
Karen Combs Beattie	Nantucket Conservation Foundation, Inc.	508 228 2884
Vincent Vacca	Concom	508-325-5180
Bruce Perry	Con Com Adm.	228 7236
Peter Wilson	Con Com Chr.	228 5618
LARRY OLIVER	COE	
Leslie Lewis	DEM - Waterways	(617) 727-3160
Wesley N. Tiffney Jr.	UMass Nant. Field Station	X549 508-228-5768
Charles L. Joyce	COE	

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Region
One Blackburn Drive
Gloucester, MA 01930

February 7, 1994

Joseph L. Ignazio
Director of Planning
Impact Analysis Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Dear Mr. Ignazio:

Thank you for your recent letter soliciting our comments regarding the Beach Erosion Control study at Siasconset Beach in Nantucket, Massachusetts. The study area includes approximately three miles of beachfront between Siasconset and the southern end of Sesachacha Pond.

In order to adequately evaluate this project, information concerning the source, grain size, and chemical composition of the beach nourishment material needs to be identified. This information is necessary to determine whether or not the source material is suitable for beach nourishment and potential erosional problems will be minimized. In addition, any future report should contain a full biological assessment of the area to be nourished as well as the borrow site. Furthermore, we recommend that in planning this project, every effort be made to avoid or reduce the filling of tidal wetlands, maintain tidal flushing and circulation, and minimize the disturbance of fish and shellfish populations.

The Massachusetts Division of Marine Fisheries informed us that Sesachacha Pond historically was open to tidal flushing and supported anadromous fish. Due to excessive sedimentation, the pond was cut off from oceanic influences. As a result, marine resources no longer are present. However, the Town and State have made efforts to restore anadromous fish and oyster populations to the pond by physically opening the pond to tidal flushing twice a year. Because of these efforts, we recommend that any feasibility study evaluate the potential of increasing the transport of sand by littoral drift thereby counteracting the town's effort to restore fish and shellfish to the pond.

As project plans develop, we request to be notified in order to make further comments at that time. If you have any questions regarding this letter, please contact Jill Ortiz at 508/281-9312.

Sincerely,

for Chris Mantzaris
Acting Chief, Habitat and
Protected Resources Division

CC: EPA - Ed Reiner
FWS - Phil Morrison
MA DMF - Greg Skomal

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Offices
22 Bridge Street, Unit #1
Concord, New Hampshire 03301-4986

February 28, 1994

Joseph L. Ignazio
Planning Directorate
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149

ATTN: Impact Analysis Division

Dear Mr. Ignazio:

This responds to your letter dated January 25, 1994 requesting information on the presence of Federally listed and proposed endangered or threatened species in relation to the proposed beach erosion control project at Siasconset Beach in Nantucket, Massachusetts.

Based on information currently available to us, the Federally threatened Atlantic Coast piping plover (Charadrius melodus) is known to occur on Siasconset Beach immediately south of the proposed project. To avoid impacting breeding piping plovers, we recommend that beach erosion control activities occur between September 15 and April 1 as outlined in the Guidelines for Barrier Beach Management in Massachusetts, Final Draft (Massachusetts Barrier Beach Task Force 1993). However, should it not be possible for disposal operations to occur within this window, we recommend that a qualified biologist survey the project area prior to erosion control activities to determine whether piping plovers have established breeding territories or are nesting. No erosion control activities or storage of vehicles or materials should occur within a 300 foot area of nesting plovers or their chicks. We suggest that you contact Scott Melvin, Division of Fisheries and Wildlife, Rt. 135, North Drive, Westboro, Massachusetts 01581, (508) 792-7270 for information on the piping plover and state guidelines for erosion control operations in rare shorebird habitat.

No other Federally listed or proposed threatened and endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area, with the exception of occasional transient endangered bald eagles (Haliaeetus leucocephalus) or peregrine falcons (Falco peregrinus anatum). We also suggest that you contact Pat Huckery of the Massachusetts Natural Heritage Program, Division of Fisheries and Wildlife at 100 Cambridge St., Boston, MA 02202, (617) 727-9194 for information on state listed species that may be present.

Thank you for your cooperation and please contact Susi von Oettingen of this office at (603) 225-1411 if we can be of further assistance.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Field Offices

March 7, 1994

Joseph L. Ignazio, Director
Planning Directorate
Impact Analysis Division
Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Attn: Marc Paiva

RE: Siasconset Beach Shore Protection Project, Nantucket, MA EOEA #9099 (MHC #9108)

Dear Mr Ignazio:

Thank you for your letter of January 14, 1994 regarding several proposals under consideration for the protection of Siasconset Beach along the eastern shore of Nantucket. These include placing sand fill along the beach from an off-shore source, constructing a de-watering or coastal drain system to increase the retention of sand, or some combination of the two.

The Massachusetts Historical Commission would like to take this opportunity to correct some of the information included in the letter regarding historic and archaeological resources within or adjacent to the study area. Sankaty Lighthouse is not the only National Register property or National Historic Landmark in the study area. The entire island of Nantucket is a National Historic Landmark and is listed in the National Register of Historic Places. There are numerous National Register properties within or adjacent to the project area for which information is available in MHC's inventory files for Nantucket. The letter mentions Auld Lang Syne, Rose Cottage and Shanunga; all three buildings are listed in the National Register and are located on Broadway in Siasconset.

Four of the prehistoric sites mentioned, (Sites 19-NT-162, -163, -164, and -165) have been determined not eligible for listing in the National Register of Historic Places. Information in MHC's site files for Site 19-NT-49 indicates that it contains Late Archaic and Early Woodland components. Historical archaeological sites NAN-HA-1, NAN-HA-4, and NAN-HA-14 are unlikely to be affected by this project as they are located some distance from the study area.

In addition, ship wrecks may exist in off-shore areas being considered as sources for beach nourishment. The MHC suggests you consult with Victor Mastone at the Board of Underwater Archaeological Resources regarding the locations of additional shipwrecks which may not be in Army Corps files.

Although MHC has previously made a "no effect" finding for a dewatering system which was proposed for this project (MHC's letter of September 8, 1993), it now appears that the project plans are being reconsidered. Therefore the MHC requests the opportunity to review more detailed descriptions of the project and plans as they become available in order to determine what effect, if any, the project may have on significant historic and archaeological resources.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 as amended (36 CFR 800), and Massachusetts General Laws, Chapter 9, Sections 26-27C, as amended by Chapter 254 of the Acts of 1988 (950 CMR 71) and MEPA.

If you have any questions, please feel free to call Connie Crosby at this office.

Sincerely,

Judith B. McDonough

Judith B. McDonough
Executive Director
Massachusetts Historical Commission
State Historic Preservation Officer

xc: Dave Shepardson, EOEA/MEPA Unit
Advisory Council on Historic Preservation
National Trust for Historic Preservation
Tom Bruha, ACE
Tom McGuire, DEP/DWWR
Lealdon Langley, DEP/ Southeast Regional Office
Victor Mastone, BUAR
Nantucket Historic District Commission
Bruce Perry, Nantucket Conservation Commission

APPENDIX B
TIDE STAGE - FREQUENCY ANALYSIS

SIASCONSET BEACH, NANTUCKET, MASSACHUSETTS
SHORE PROTECTION
SECTION 103 RECONNAISSANCE STUDY
TIDE STAGE-FREQUENCY ANALYSIS

1. BACKGROUND

Siasconset Beach is on the extreme eastern side of Nantucket Island. As tidal erosion has eaten away a significant part of the beach and some houses have been lost, the town has requested the Corps to conduct a shore protection study. Figure 1 shows location of the study area. As part of this study, Water Control Division prepared a tide stage-frequency curve.

2. GAGES

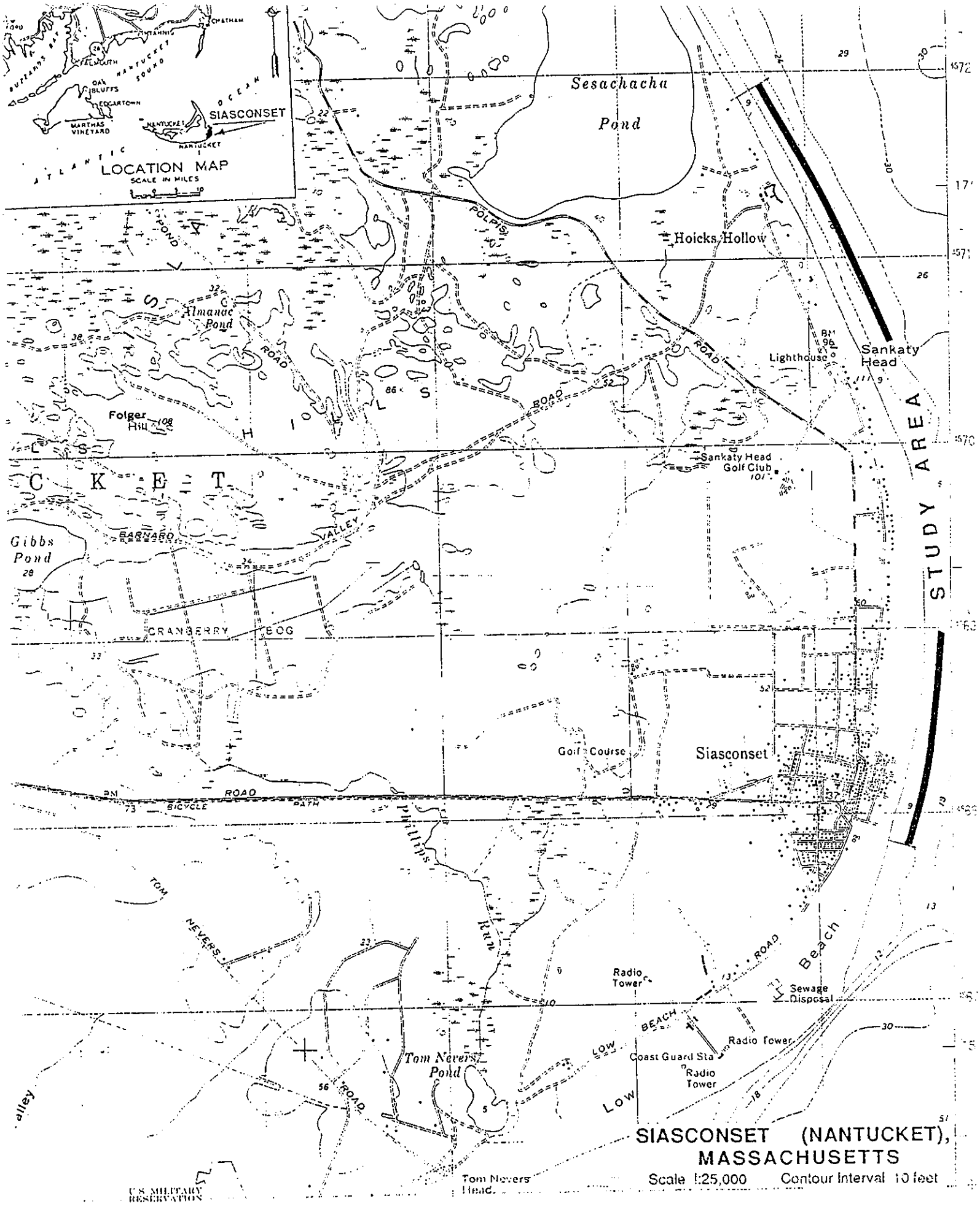
There are no tide gages at the beach, the closest one, with sufficient periods of record, is in Nantucket Harbor, and is maintained by the National Oceanic and Atmospheric Administration (NOAA), Rockville, Maryland. As shown in figure 2, the gage is on the other side of the beach, facing open water to the north; consequently, tidal conditions will vary between the harbor and beach. Since there are no other gages on the island, and stillwater ocean levels at the beach and gage should be reasonably close; the harbor gage record was used. Available periods of record for the gage is from 1965 through 1992. The 1993 data we requested from NOAA was not received in time of preparation of this report.

3. DATUM

Corps studies usually reference tide levels to NGVD; however, NGVD has not been carried out to islands such as Nantucket; a check was made with NOAA to confirm this. Due to absence of such a datum, elevations on the island are referred to mean tide level (MTL), which is an average of all high and low tides. Because there is no long-term fixed reference such as NGVD on the island, no adjustments were made in the record to account for rising sea level.

4. ADJUSTMENTS

Gage data were adjusted to mean low water (MLW) at Nantucket, using adjustments ranging from -2.91 to -2.96 feet, and MLW was then adjusted to mean tide level by adding amounts ranging from 4.44 to 4.49 feet based, on data


LOCATION MAP
SCALE IN MILES
SIASCONSET
Sesachacha Pond
Hoicks Hollow
Almanac Pond
Folger Hill
Sankaty Head
Lighthouse
Sankaty Head Golf Club
STUDY AREA
Gibbs Pond
CRANBERRY BOG
Golf Course
Siasconset
BICYCLE PATH
Tom Nevers Run
Radio Tower
Sewage Disposal
Coast Guard Sta
Tom Nevers Pond
Tom Nevers Head
U.S. MILITARY RESERVATION
SIASCONSET (NANTUCKET), MASSACHUSETTS
Scale 1:25,000 Contour Interval 10 feet

B-2

Figure 1

TIDE GAGE LOCATIONS

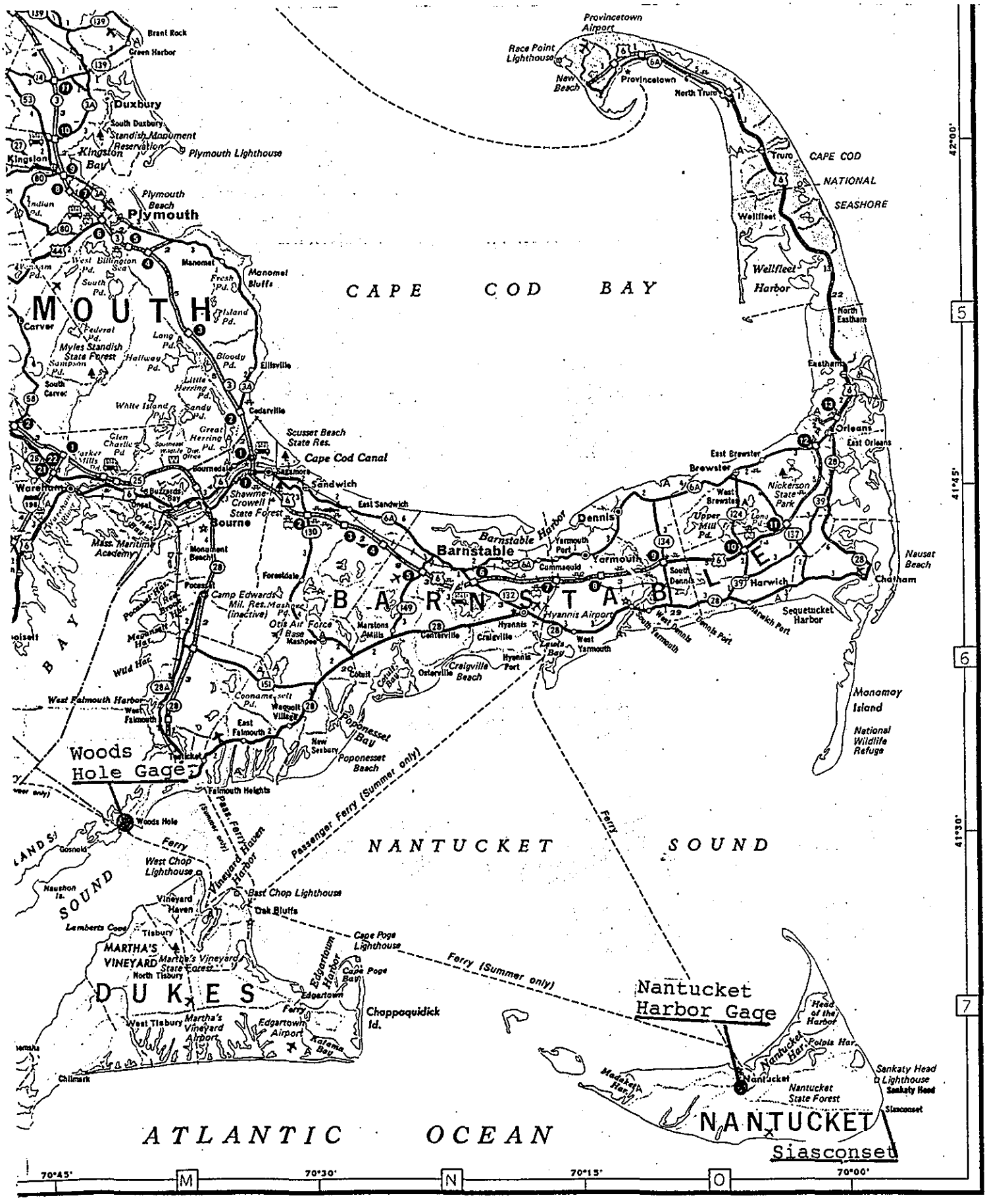


Figure 2

references provided by NOAA. Adjustment to mid-tide levels for the period 1970-74 was interpolated from data references in 1969 and 1975. Table 1 shows gage readings and mean tide levels used in this study; this table also shows the missing months from the period of record.

5. CORRELATIONS

The tide gage in Woods Hole, Massachusetts (figure 2), is the closest one to the Nantucket gage, and a correlation was developed between them to fill in the missing months and extend the period of record. However, the correlation was inadequate for use. Although the Woods Hole gage is not far from the Nantucket gage, tidal conditions are very different.

6. COMPUTATIONS

The Flood Frequency Analysis program developed by the Hydrologic Engineering Center, May 1992 version, was used to develop the stage-frequency curve. Because this was tidal data, logarithmic transformation was not used, and a regional skew of 2.434 was adopted based on experience at other tide gages along the southern New England coast.

7. RESULTS

The expected exceedance frequency for stillwater tide stages at Siasconset are displayed in table 2 and figure 3.

TABLE 1

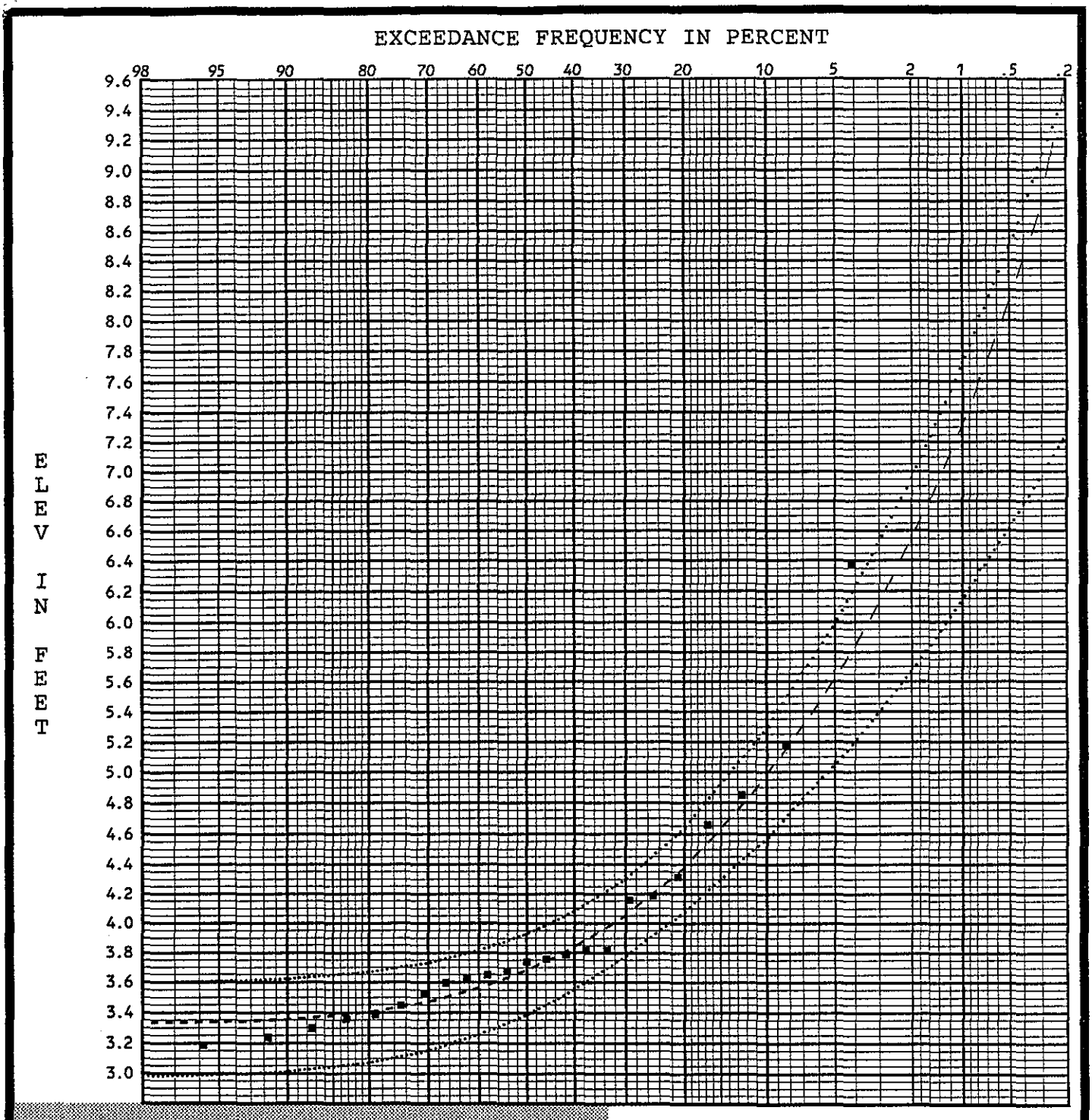
NANTUCKET HARBOR TIDE GAGE RECORD

Year	Date	Gage Reading HHW	Adjmnt	MLW	Adjmnt	MTL	Missing Months
1965	7-01,-28	7.4	2.91	4.49	4.44	2.96	Jan
1966	12-29	8.1	2.91	5.19	4.44	3.66	Jun-Aug
1967	4-29	8.6	2.91	5.69	4.44	4.16	Jul, Dec
1968	11-12	8.5	2.91	5.59	4.44	4.06	Jan-Jul
1969	2-10	8.4	2.91	5.49	4.44	3.96	Apr
1970	12-26	8.2	2.91	5.29	4.44	3.76	Jul
1971	3-28	8.04	2.91	5.13	4.44	3.60	Dec
1972	2-19	8.6	2.91	5.69	4.44	4.16	Jan
1973	3-23	8.63	2.91	5.72	4.44	4.19	
1974	2-07	7.74	2.91	4.83	4.44	3.30	Aug-Oct
1975	12-22	7.71	2.94	4.77	4.47	3.24	
1976	3-17	8.21	2.94	5.27	4.47	3.74	
1977	1-10,10-1	7.86	2.94	4.92	4.47	3.39	
1978	2-07	9.13	2.94	6.19	4.47	4.66	Apr
1979	1-25	8.79	2.94	5.85	4.47	4.32	Feb
1980	3-22	7.92	2.94	4.98	4.47	3.45	
1981	11-16	8	2.94	5.06	4.47	3.53	Jan
1982	10-09	8.26	2.94	5.32	4.47	3.79	
1983	11-25	8.29	2.94	5.35	4.47	3.82	
1984	3-29	8.13	2.95	5.18	4.48	3.65	
1985	1-05	8.12	2.96	5.16	4.49	3.63	
1986	12-31	8.31	2.96	5.36	4.49	3.82	
1987	1-02	9.34	2.96	6.38	4.49	4.85	
1988	2-16	7.68	2.96	4.72	4.49	3.19	
1989	1-04	7.85	2.96	4.89	4.49	3.36	
1990	12-04	8.17	2.96	5.21	4.49	3.68	
1991	10-30	10.87	2.96	7.91	4.49	6.38	
1992	12-12	9.67	2.96	6.71	4.49	5.18	Aug-Dec

TABLE 2

NANTUCKET TIDE GAGE
STILLWATER TIDE STAGE-FREQUENCY
EXPECTED PROBABILITY

Exceedance Frequency	Stage in Feet Above MTL
90	3.3
50	3.7
20	4.4
10	5.0
5	5.6
2	6.6
1	7.3



--- Elev Frequency (with Exp. Prob.)
▪ Weibull Plotting Positions
····· 5% and 95% Confidence Limits

FREQUENCY STATISTICS NO TRANSFORM OF ELEV, FEET		NUMBER OF EVENTS	
MEAN	3.9	HISTORIC EVENTS	0
STANDARD DEV	.7	HIGH OUTLIERS	0
SKEW	1.9340	LOW OUTLIERS	0
REGIONAL SKEW	2.4234	ZERO OR MISSING	0
ADOPTED SKEW	2.4234	SYSTEMATIC EVENTS	23

NANTUCKET, MA
STAGE-FREQUENCY CURVE
USGS GAGE AT NANTUCKET, MA

ELEVATIONS ABOVE
MEAN TIDE LEVEL

Figure 3

APPENDIX C

RECONNAISSANCE LEVEL ENGINEERING STUDY

CENED-ED-DE (335-2-5a) 2 May 1994
Lemire/jdd/7556

MEMORANDUM FOR Director of Planning

SUBJECT: A Reconnaissance Level Engineering Study of the Erosion Occurring Along the Codfish Park Section of the Siasconset Area of Nantucket, MA

1. As requested by your project manager, Mr. Charles Joyce, a reconnaissance level engineering study of the erosion in the subject project area has been completed by the Coastal Engineering and Survey Branch.

2. Nantucket Island lies approximately 30 miles south of Chatham on Cape Cod, and about 20 miles east of Martha's Vineyard. This island is approximately 13 miles wide (east to west) and 9 miles long (north to south). It is bounded by the Atlantic Ocean to the south and east, Muskeget Channel to the west, and Nantucket Sound to the north. It is accepted that Nantucket Island is part of a terminal moraine left after the last glacial epoch affecting this area. The island is composed of unconsolidated glacial and marine sediments.

3. The study area is located in the Siasconset part of Nantucket known as Codfish Park. Codfish Park is a residential area built on a 300-foot-wide (±) section of backshore. It is bounded by 20-foot-high (±) bluffs on its landward side. The elevation of the backshore area varies from about elevation 12.5 feet above half tide level (HTL) at the top of the beach scarp between the foreshore and backshore on the seaward side, to elevation 15.5 feet (HTL) at the toe of the bluffs.

4. The problem is one of ongoing erosion. Several studies have reviewed the coastal erosion problem along the easterly shore of this island: Sankaty Head Light Station Nantucket, MA, U.S. Army Corps of Engineers, New England Division 1989; Nantucket Shoreline Study, MIT Sea Grant College Report, 1979; Siasconset Erosion Committee Report (Unpublished Letter Reports), Dr. Franklin W. Fessenden, 1988 to present, each of which have indicated that high rates of erosion have occurred over non-uniform time periods and at varying locations in the study area. From all available information, this problem is not unique to present day conditions, but has historic precedence.

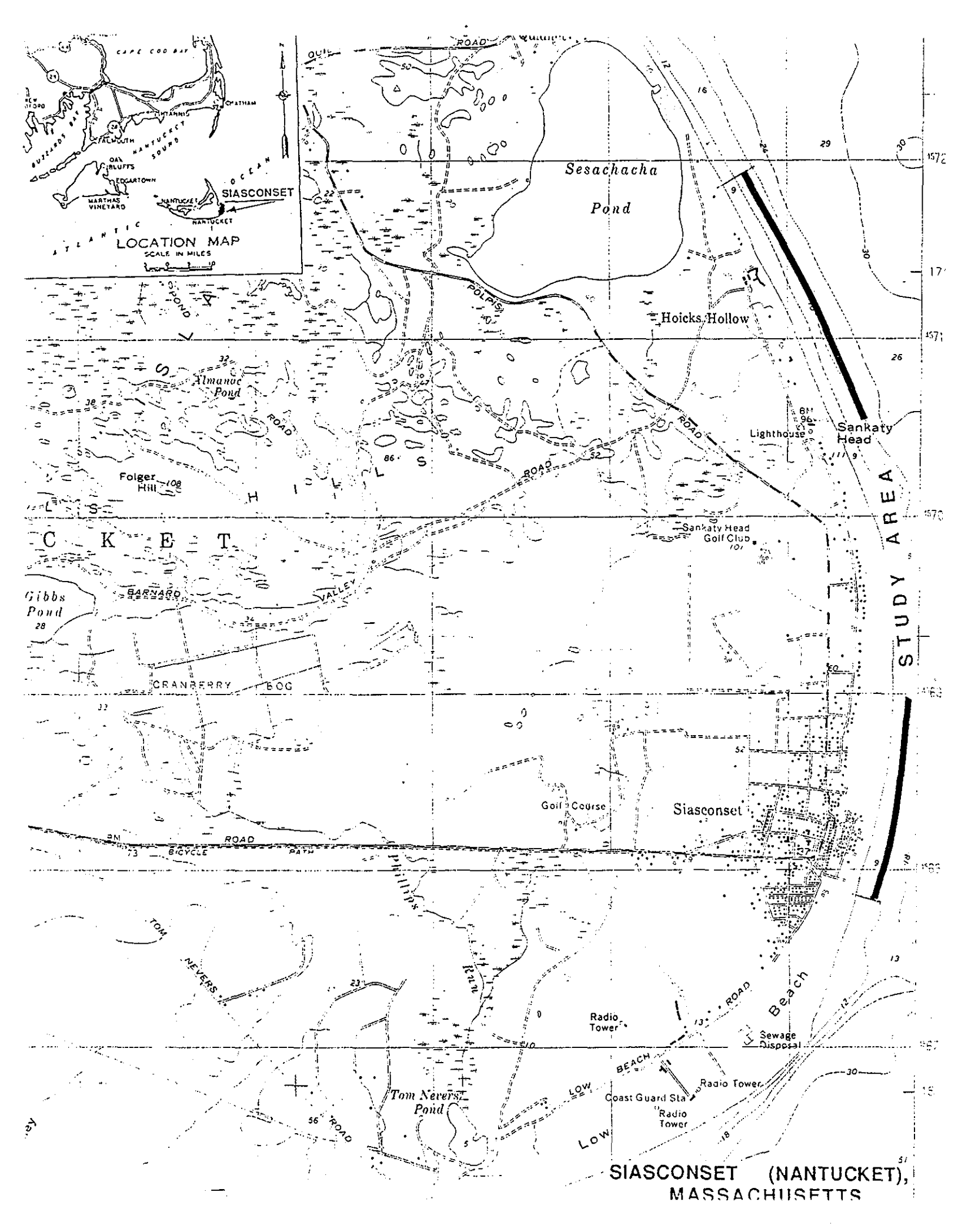
5. The available nearshore bathymetry does not show any offshore bar development along the Codfish Park coastline area. This indicates that the sediments being eroded in this area are either being lost to deeper offshore water or to some other longshore updrift point, the net result being that the material is not available for seasonal nourishment on the existing beach.

6. For about three miles along Nantucket's easterly coastline, from about 1/2 mile north of the sewerage treatment plant to Hoicks Hollow at the northerly end of the study area, the beach has been continually receding. In the Fessenden study, a 3,600-foot section of the coastline centered on the Codfish Park area showed a recession of 64 feet from 1988 to 1990 while one specific area within this section had receded over 90 feet during the same period. North of the Codfish Park area the recession has progressed to the point where there is essentially no backshore beach, and the foreshore is now at the toe of the bluffs. As a result, the bluffs are now being undercut by wave action. The material then sloughs off onto the beach and provides fill for a new fronting beach. The process continues until the foreshore is again at the toe of the bluffs and wave action once again undercuts these bluffs creating a new beach. This condition presently exists from about 1/4 mile north of the Codfish Park area to Hoicks Hollow. However, there is some evidence that this condition is moving southward towards the Codfish Park area.

7. In order to obtain an estimate of the average annual volume of material lost to the system along the east shore of Nantucket Island, the recessional shore lines presented in Dr. Fessenden's data were superimposed on topographic maps of the area. Using these plots, and assuming foreshore and nearshore slopes typically found in this area (1 vertical to 10 horizontal), the estimated volume of material lost was calculated. Based on the above considerations, and assuming a uniform recession rate, it is estimated that 80,000 c.y. of beach fill is removed from the system annually along the east shore of Nantucket Island. Of this total volume, it is estimated that 17,000 c.y. comes from the exposed bluffs.

8. Of the total average annual loss it is estimated the Codfish Park area contributes about 20 to 25% of the total, or about 20,000 c.y.

9. Information contained in Hindcast Wave Information for the U.S. Atlantic Coast (WIS Report 30, Mar 1993, buoy 44011) was used to develop a wind speed vs. percent exceedence curve in order to determine a design wind speed needed for use with the Automated Coastal Engineering System (ACES) program for determining wave heights.



SIASCONSET (NANTUCKET), MASSACHUSETTS

10. To maximize the wave heights for a particular wind condition, the duration of each storm was varied for a given wind speed until a fully developed sea state occurred. In this study two wave conditions, representing two probabilities of exceedence, were chosen to be used in the beach design: 100-year event, significant wave height (Hmo) = 18.4 feet, peak spectral period (Tp) = 12.5 sec.; and, 50-year event, (Hmo) = 14.7 feet, (Tp) = 11.1 sec.

11. The design elevation of the proposed beach berm was obtained from the sum of the still water level (SWL) (tide plus storm surge), wave setup (Sw) and wave runup (Ru). The SWL elevation was obtained from a tide stage frequency curve (1965 through 1992) for Nantucket Harbor. Even though the harbor is fronting Nantucket Sound, and the study area is fronting the Atlantic Ocean, it is felt that the difference between the two is minimal. The Sw was determined using the U.S. Army Corps of Engineers' Shore Protection Manual Wave Setup Due to Monochromatic Waves, where the maximum wave was taken as the root-mean squared wave height (Hrms) from a Beta-Rayleigh Wave Distribution of Hmo compared to the wave height limited to 78% of the water depth at the point of breaking. The smaller of these two values was used to determine the Sw value. Finally, the Ru value was obtained using the ACES program where the mean significant wave height was taken as the maximum wave in the Sw calculation.

12. Because no offshore bar has formed from the eroded sediments, either due to a dominant longshore drift or the material being lost to deeper offshore waters, this section of coastline does not exhibit a conservation of material along its cross-sectional profiles. As a result, the latest analytical techniques which are used to optimize fill shape based on cross-shore profile erosional response [Storm Induced Beach Change (SBEACH)] are not applicable for use at this project site.

13. Therefore, an approach based on engineering judgement and past experience has dictated that a fill slope of 1 vertical (V) to 15 horizontal (H) be used for this study. This slope appears more effective than the existing beach slope of 1V to 10H in reducing the severity of the plunging breaking waves that are common along this coastline and in reducing (approximately 2 feet) the required berm elevation necessary to control runup and overtopping. This approach yields a design berm elevation of 16.5 feet HTL for a 100-year event and 12.5 feet for a 50-year event.

14. Allowing that there has been up to almost 100 feet of coastal recession in the Codfish Park area in a two-year period, the initial berm width was taken to be 100 feet wide. The volume for the two evaluated storm events were calculated as:

Event (Yr)	Berm Width (ft)	Feet Above (HTL) Elevation	Fill Volume * (c.y.)
100	100	16.5	670,000
50	100	12.5	400,000

* These volumes were developed for base protection and do not include advance beach nourishment.

15. The cost estimates (see attachment) that were developed for providing the required fill assume that the borrow area is not more than six miles from the project site; that a hopper dredge can come within 1,200 feet of the beach, and that the borrow area has suitable material in sufficient quantities to complete the project. It was also assumed that no environmental factors restrict access to the project site or the borrow material, nor do they add inordinately to the cost. The total project cost, including Engineering and Design and Construction Management is:

Event Yr	Cost
100	$8,026,000
50	$5,076,000

16. The time to complete this work is 3.6 months and 2.2 months for the 100-year protection and 50-year protection, respectively.

17. Conclusion: Due to the physical location of the project site and its varying unpredictable erosion rates and patterns, a much more extensive study is needed prior to being able to recommend, with any confidence, that beach fill is a valid means of long-term storm damage protection for the area.

CENED-ED-DE (335-2-5a) 2 May 1994
SUBJECT: A Reconnaissance Level Engineering Study of the Erosion Occurring Along the Codfish Park Section of the Siasconset Area of Nantucket, MA

18. Recommendations: It is strongly recommended that a sediment transport study be conducted to determine the pattern of sediment drift and deposition that is occurring in the area prior to any project being assigned to this site. Without this information, the stability and effectiveness of any fill placed along the coastline fronting Codfish Park is questionable.

19. If you have any questions please contact Mr. Al Lemire on extension 7556.

Atch

RICHARD D. REARDON
Director of Engineering

CF:
Mr. Lemire, 112N
Engrg Dir Files, 112S

APPENDIX D

ECONOMIC ANALYSIS

WATER RESOURCE IMPROVEMENT STUDY

SIASCONSET BEACH

NANTUCKET, MASSACHUSETTS

SHORE PROTECTION AND EROSION CONTROL PROJECT
RECONNAISSANCE REPORT

APPENDIX D
ECONOMIC ANALYSIS

APRIL 1994

PREPARED BY:

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

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LIST OF TABLES

INTRODUCTION

The purpose of this report is to provide an economic analysis of potential hurricane and storm damage reduction benefits in the Siasconset Beach area of Nantucket, Massachusetts. Plans that reduce hurricane and storm damages are evaluated. For each plan annual benefits are divided by annual costs to determine a benefit/cost ratio. This ratio must be equal to or greater than one for Federal participation in water resource improvement projects.

METHODOLOGY

Benefits and costs are made comparable by conversion to average annual equivalents. An interest rate of 8% as specified in the Federal Register is to be used by Federal agencies in the formulation and evaluation of water and land resource plans for the period 1 October 1993 to 30 September 1994. All costs and benefits are stated at the 1994 price level. The project economic life is considered to be 50 years. The analysis of costs and benefits follows standard U.S. Army Corps of Engineers procedures described in the National Economic Development Manual, Coastal Storm Damage and Erosion.

STUDY AREA

Siasconset is located in the Town of Nantucket, Nantucket County, Massachusetts. Nantucket, the largest of the group of islands which form the county, is about 16 miles south of the Cape Cod shoreline in the Atlantic Ocean. The island at its greatest extremes, is about 15 miles from east to west and 10 miles from north to south. Siasconset is on the eastern end of the island. The 1990 population was 6,012. Nantucket is a resort town with the majority of its civilian employment and payroll concentrated in service and retail trade.

The Siasconset Beach study area extends from Codfish Park in the south approximately 3 miles to Hoicks Hollow in the north. This area is experiencing annual erosion rates of 6-7 feet in the southern sections and 3-4 feet in the northern sections. The Siasconset Erosion Committee has established 13 areas (transects) to measure shoreline erosion. Inhabitants of Codfish Park are also experiencing storm damage. For study purposes the shoreline is divided into three areas. Area 1, Codfish Park, is between transects 83 and 86. Area 2 is between transects 86 and 93. Area 3 is between transects 93 and 97.

WITHOUT PROJECT CONDITION

The major types of damages are storm damages and erosion damages. Storm damages are caused by inundation, wave attack and shoreline recession. Inundation damages are related to still water flood elevations. Wave attack is damage caused by waves

breaking over structures. Storm recession is the landward movement of the shoreline during storm events potentially damaging structures.

Storm Damage

Storm damages occur only in the Codfish Park area. This area lies between transects 83 and 86. There are approximately 58 residential structures in this reach that could potentially receive storm damage. The number of structures in the floodplain was estimated through use of photographs, aerials and contour maps. The designation floodplain is used. However, damages also are due to wave attack and storm recession.

Inundation

Inundation damages were developed for each property using a stage damage function for a typical residential structure in this neighborhood. The stage or elevation at which flood damage begins was determined to be at the ground elevation for each property. Estimates of potential damages were then made from this point, in one foot increments of stage, to a level 6 feet above the first floor. Dollar value estimates were made for physical damages to site, structure, contents and utilities. Seepage through the bottom of the foundation was not assumed as the start of damage.

Stage damage estimates for residential properties were prepared using typical stage damage relationships for a two story structure with basement. First floor and ground elevations at each building were estimated from contours on 2.5 foot topographical mapping. In most cases the first floor appears to be approximately three feet above the ground elevation. The ground elevations east of Codfish Park Road appear to be at 12.5 feet above mean tide. Structures west of the road appear to be at elevation 14.

Typical damages in one foot increments for 1994 prices is shown in Table 1. This damage function represents a two story structure with basement. Damages below the first floor (FF) are mostly to utilities.

Table 1
Residential Stage Damage Relationship ($000)

-3	-2	-1	FF	1	2	3	4	5	6
11.8	11.8	11.8	26.6	38.6	52.6	66.6	66.6	66.6	68.1

Storm recurrence intervals and their respective elevations above mean tide are shown below in Table 2.

Table 2
Without Project Stage Frequency
Elevations above Mean Tide Level

Return Interval (Years)	Elevation (Feet)
500	24.0
100	18.5
50	14.8
10	9.0
5	7.1

Source: NED, Coastal Engineering Division.

Flood damages were developed using a program developed by the New England Division (NED) in Lotus. Stage damage information for each of the residential housing units was input. The elevation of the first floor and the elevation at which damage starts were also input for each structure. Stage frequency data for this reach were then input. The computer model combined stage-frequency data and stage-damage information to compute damage frequency and expected annual damage. Expected damages were calculated for each structure and annualized. Expected damages become zero at the point when the structure is lost due to long term erosion. Recurring damages are are associated with different return intervals, or frequencies. They are shown in Table 3. Damages decline over time as structures are lost to erosion and drop out of the storm damage inventory.

Table 3
Recurring Inundation
Damages

Reccur-ence	Year 1	Year 10	Year 20	Year 30	Year 40
Interval					
(years)					
5	0	0	0	0	
10	0	0	0	0	
50	$670,700	$528,800	$399,500	$188,000	$23,500
100	$2,437,900	$2,053,100	$1,551,300	$730,000	$91,300
500	$3,406,900	$2,998,100	$2,265,300	$1,066,000	$133,300

As mentioned previously, recurring losses relate the dollar value of flood damage to specific flood depths. For the purpose of determining the severity of potential flooding in each damage reach, the statistical concept of "expected value" is employed. Annual losses for Codfish Park are simply the integration of two sets of data: (i) recurring losses displayed in one-foot increments of flood depth from the start of damage to the elevation 6 feet above the first floor and (ii) the estimated annual percent chance that flood levels will exceed each elevation for which recurring losses were estimated. Simply, the probability of exceeding a specific flood stage during any given year is multiplied by the corresponding dollar value of damage. The summation of these expected values results in potential annual losses. The effectiveness of a flood reduction plan is measured by the extent to which it reduces annual losses. The stage frequency information found in Table 2 was used to estimate expected annual damages. Expected annual damage due to inundation for the Codfish Park area is estimated to be $39,500.

Wave Attack

The wave attack frequency relationship is defined as the return period of the storm event that allows wave runup to destroy residential structures. The wave attack line is the position in the runup zone where the force due to the breaking wave exceeds the critical force needed to destroy the structure. This force is estimated to be 1770 lbs/sq ft, equivalent to a breaking wave height of approximately 3 feet. Based on information provided by Coastal Engineering Division, that the wave associated with a 100 year storm will maintain at least a 3 foot height for a distance of approximately 230 feet from the shoreline. The distance from the shoreline to high ground is approximately 350 feet. Structures in this entire reach would be impacted by at least a three foot wave in the 500 year event. In estimating wave height it is assumed that the wave will lose 75 % of its height from the shoreline to the end of the backshore. The height at which it falls below 3 feet is interpolated between these two points. It is assumed that a wave of at least 3 feet in height will cause damage equal to 50 % of the structure value. Expected annual damages from wave attack for 51 structures is estimated to be $7,500.

Storm Recession

Storm recession damages are not calculated here. The rationale of storm recession damages is that the beach will retreat landward as the result of the storm. Following the storm, however, in most cases the beach will accret and property damaged as a result of the storm induced erosion will be rebuilt. Coastal engineering analysis indicates that for Codfish Park sand lost during a storm does not return. Thus damages due to beach recession, or erosion, are described below under long term erosion damage.

To avoid double counting of damages, inundation damages are usually compared with wave attack damages for each structure. The larger value is then used in calculating expected annual damages. This is referred to as the critical value method for determining expected annual storm damages. In this case since inundation natural damages are much larger than wave attack natural damages, inundation damages will be used to measure storm damage.

Erosion Damage

Erosion damage refers to the long term sand loss which in Codfish Park is approximately 6-7 feet per year. As a result of this process structures are destroyed and land is lost.

Structures

Structures are considered to be totally damaged when erosion reaches the midpoint of the structure. No damage is calculated until erosion reaches this point. Structural damage was based on assessed values that were converted to market values. In the Codfish Park area (between transects 83 and 86) an average value was used as many assessments were not collected. This average market value was $46,000. Data for the remaining structures was more complete with only a few missing assessments. Average structural value for the remaining areas was $223,000. This average was substituted for missing assessments. Sankaty Lighthouse (between transects 92 and 93) was valued at $2,000,000. Annualized erosion damages are shown below in Table 4.

If sufficient land existed on an individual's property it was assumed that the structure would be relocated. This would apply to property on Baxter Road. It was further assumed that the structures would be relocated 5 years before they would be lost to erosion. Relocation cost is estimated to be $62,500 per structure.

Table 4
Erosion Induced Damages
(Structures)

TRANSECT		EROSION DAMAGE
83 to 85		$42,400
85 to 86		$9,100
86 to 87		$600
87 to 88		$0
88 to 89		$0
89 to 90		$2,500
90 to 91		$40,700
91 to 92		$14,100
92 to 93		$122,200
93 to 94		$0
94 to 95		$2,900
95 to 96		$14,600
96 to 97		$10,700

Loss of Land

Land loss is based on annual rates of erosion. The land lost is valued at backshore prices. This information was obtained from the Nantucket Tax Assessors Office. The amount of land lost and its value is shown below in Table 5 by transect area. Loss of land is only calculated for developable land. Land that is used for recreation or is beach or is wetland is not included in the analysis. The extent of developable land was determined by inspection of aerials and photographs. Erosion rates were provided by the Siasconset Beach Preservation Fund, Inc. The length of developable shoreline multiplied by the average erosion rate determines the annual amount of square feet that is lost. This is multiplied by $21.25 to determine the value of land that is lost. The value of developable land lost is shown below in Table 5.

Table 5
Loss of Land

TRANSECT	TOTAL LENGTH (feet)	DEVELOPED LENGTH (feet)	EROSION RATE (ft/yr)	DEVELOPED AREA LOST (sq ft)	VALUE LOST
83 to 85	2100	1250	6.6	8250	$175,300
85 to 86	500	400	6.7	2680	$57,000
86 to 87	850	0	5.8	0	$0
87 to 88	1600	0	7.7	0	$0
88 to 89	725	0	7	0	$0
89 to 90	1075	600	5.3	3180	$67,600
90 to 91	1400	1400	6.6	9240	$196,400
91 to 92	900	900	5.5	4950	$105,200
92 to 93	1125	1125	3.1	3488	$74,100
93 to 94	1100	1100	4.3	4730	$100,500
94 to 95	725	725	3	2175	$46,200
95 to 96	1900	1900	3.1	5890	$125,200
96 to 97	1750	1750	3.1	5425	$115,300
Beyond 97			2.9	0	$0
TOTAL	15,750	11,150		50,008	$1,062,800

In the calculation of without project damages once a house is moved or damaged expected annual storm damages for that structure become zero. This avoids double counting that could occur if these structures were not removed from the structure inventory.

A severe long term erosion problem could reduce property market values. Discussions with the Nantucket Tax Assessor reveal that the assessments used in this analysis have not been affected by potential damages due to erosion. However, future assessments will likely reflect declining property values due to long term erosion. Without project erosion damages are summarized in Table 6 by Study Area.

Table 6
Ersosion Damage Summary

		LAND	STRUCTURES	
AREA	TRANSECTS	VALUE LOST	DAMAGED	TOTAL
1	83 TO 86	$232,300	$51,500	$283,800
2	86 TO 93	$443,300	$180,100	$623,400
3	93 TO 97	$387,200	$28,200	$415,400
Total		$1,062,800	$259,800	$1,322,600

WITH PROJECT CONDITITON

Improvement Plans

The improvement plan is a beach to protect the Codfish Park area. This reach was selected due to a high concentration of houses. Additionally, these structures are susceptible to storm damage. Structures in other reaches are situated at elevations that place them above storm damage. Two beach options were evaluated that would provide protection against a 50-year event and a 100-year event.

Storm Damage

The beach will reduce wave runup resulting in lower stillwater levels thereby reducing inundation damages. Estimated stillwater levels with the beach in place are shown in Table 7.

Table 7
With Project Stage Frequency,
Elevation above Mean Tide Level

Return Interval (Years)	Elevation (Feet)
500	20.8
100	16.1
50	12.8
10	8.1
5	6.5

Source: NED, Coastal Engineering Division.

The stage frequency information in Table 7 was used to estimate modified (with project) inundation damages. With the project flooding damages are estimated to be $29,600 annually with a 50-year level of protection and $24,400 with a 100-year level of protection.

The project will reduce the number of structures that are susceptible to wave attack for storms of various frequencies, or return intervals. With a project the wave attack line will be reduced from 230 feet in the natural condition to 80 feet for a 100 year event. The wave attack line will be reduced from 350 feet to 300 feet for 500-year event. With a 50-year level of protection expected damages from wave attack are estimated to be $3,600. With a 100-year level of protection expected annual damages from wave attack are estimated to be $2,300.

One reason that residual damages are high is that in the with project condition the structure is susceptible to damage over the 50 year project life. In the without project condition storm related damages stop when the building becomes permanently damaged due to long term erosion.

Erosion Damage

With either beach in place long term erosion is expected to be contained. Thus it is not expected that any structures would be totally damaged. This annualized damage prevention is estimated to be $51,500 for Codfish Park.

The project also prevents loss of land. The annualized value of land not lost is estimated to be $232,300 for Codfish Park.

PROJECT BENEFIT

Project benefit is measured by the reduction in storm related damage and reduction in loss of land and property damage associated with long term erosion. Benefits are shown in Tables 8 and 9. As the plan of improvement includes only Codfish Park, benefits only apply for this area. Total annual project benefit is estimated to be $293,700 for the 50 year Level of Protection and $298,900 for the 100 year level of protection. Residual storm damages are high partially because with the project in place, storm damages will continue over the 50 year project life. In the without project condition storm damages cease when the property is destroyed. Project benefits are shown below in Table 8 for the 50 year level of protection and Table 9 for the 100 year level of protection.

Table 8
Project Benefit
50 Year Level of Protection

	Without Project	With Project	Benefit
Storm Damage			
Inundation	$39,500	$29,600	$9,900
Wave Attack	$7,500	$3,600	$3,900
Long term Erosion			
Structural Dam	$51,500	$0	$51,500
Loss of Land	$232,300	$0	$232,300
Total	$323,300	$29,600	$293,700

Note: Wave Attack damages are not included in totals to avoid double counting of benefits.

Table 9
Project Benefit
100 Year Level of Protection

		Without Project	With Project	Benefit
Storm Damage				
Inundation		$39,500	$24,400	$15,100
Wave Attack		$7,500	$2,300	$5,200
Long term Erosion				
Structural Dam		$51,500	$0	$51,500
Loss of Land		$232,300	$0	$232,300
Total		$323,300	$24,400	$298,900

Note: Wave Attack damages are not inlcuded in totals to avoid double counting of benefits.

PROJECT RISK AND UNCERTAINTY

There is a probability that the project will fail. For the 50 year level of protection there is a 2 percent chance that a storm will exceed the beach's elevation in any given year and 1 percent chance for the 100 year level of protection. Given that any sand lost to storm induced erosion does not return to the system, maintenance costs will be high, or if the beach is not replaced, then benefits will cease. Using the binomial distribution, over the project life of 50 years there is a 64% chance that 50-year beach will fail and a 40% chance that the 100-year beach will fail.

SYSTEMS ANALYSIS

This analysis does not address project impact outside the immediate project area. The impacts of any accretion or decretion of sand outside this area as a result of the project would need to be addressed in further studies of storm damage and erosion in Siasconset.